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Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

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LORIN IVES NEVLING, JR.
} Associate Editors

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THE PHYTOGEOGRAPHY OF SUBALPINE BLACK SPRUCE IN NEW ENGLAND

JAMES A. TEERI[1]

Prostrate plants of black spruce (*Picea mariana* (Mill.) BSP.) occur above the treeline on many of the higher mountains of northern New England. The dwarf spruces appear to belong to a subalpine race adapted to the cool, windy upper-montane environment. The present study resulted in the re-elevation of the short-needled prostrate plants to varietal status. Possible origins and phytogeographic relations of the variety are discussed with respect to recent interpretations of late-glacial events in northeastern North America.

Picea mariana (Mill.) BSP. var. **semiprostrata** (Peck) comb. nov. Based on *Picea brevifolia* var. *semiprostrata* Peck, Rep. Bot. N.Y. State Mus. 283. 1897.

Plants of var. *semiprostrata* lack a single upright apex, and may or may not possess a single horizontal main stem (fig. 1a, b). The needles average about 4 mm in length, with a range of 2.2 to 5.5 millimeters. The needles are thick, glaucous, and slightly adaxially curved. Glandular-tipped trichomes profusely cover the new growth during the first year. These plants have a prostrate growth form usually less than 4 dm in height. The average amount of annual apical elongation is about 3 centimeters. Plants of

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var. *semiprostrata* occur in the subalpine regions of the higher mountains of northeastern North America.

Peck (1897) described *Picea brevifolia* var. *semiprostrata* as a ". . . small, half-prostrate, shrub-like spruce . . . on the exposed summits of the high peaks of the Adirondack mountains." He based the variety on short needles and glaucous foliage. Rehder (1907) later described *Picea mariana* var. *brevifolia* as a small tree usually found in ". . . mountain bogs . . ." of northeastern North America. The var. *brevifolia* was characterized by needles 4 to 12 mm in length. Rehder recognized that the variety he described did not include the most prostrate, short-needled black spruce of the mountains. He mentioned: "The low prostrate form of the exposed tops of high mountains described by Peck as *P. brevifolia* var. *semiprostrata*, will probably also be found in New England." Blake (1913) recombined *Picea brevifolia* var. *semiprostrata* Peck to *P. mariana* f. *semiprostrata* (Peck) Blake. The plant thus described had ". . . a creeping alpine form . . ." and needles 3 to 6 mm in length. The present information indicates that Blake's concept of the f. *semiprostrata* is the same as *P. mariana* var. *semiprostrata*.

Black spruce becomes dominant in the flora at treeline in many of the higher mountains of New England. The spruce plants below the treeline and at treeline are of the partially upright growth form (fig. 1c) or the normal tree form (fig. 1d). These two forms are about 2½ to 3 meters in height, and have needles with an average length of 7.5 to 8.5 millimeters. The range in needle length is from 5.0 to about 9.0 mm in plants of these two forms. Above the treeline, black spruce occurs in growth forms varying from partially upright to prostrate (fig. 1b). The

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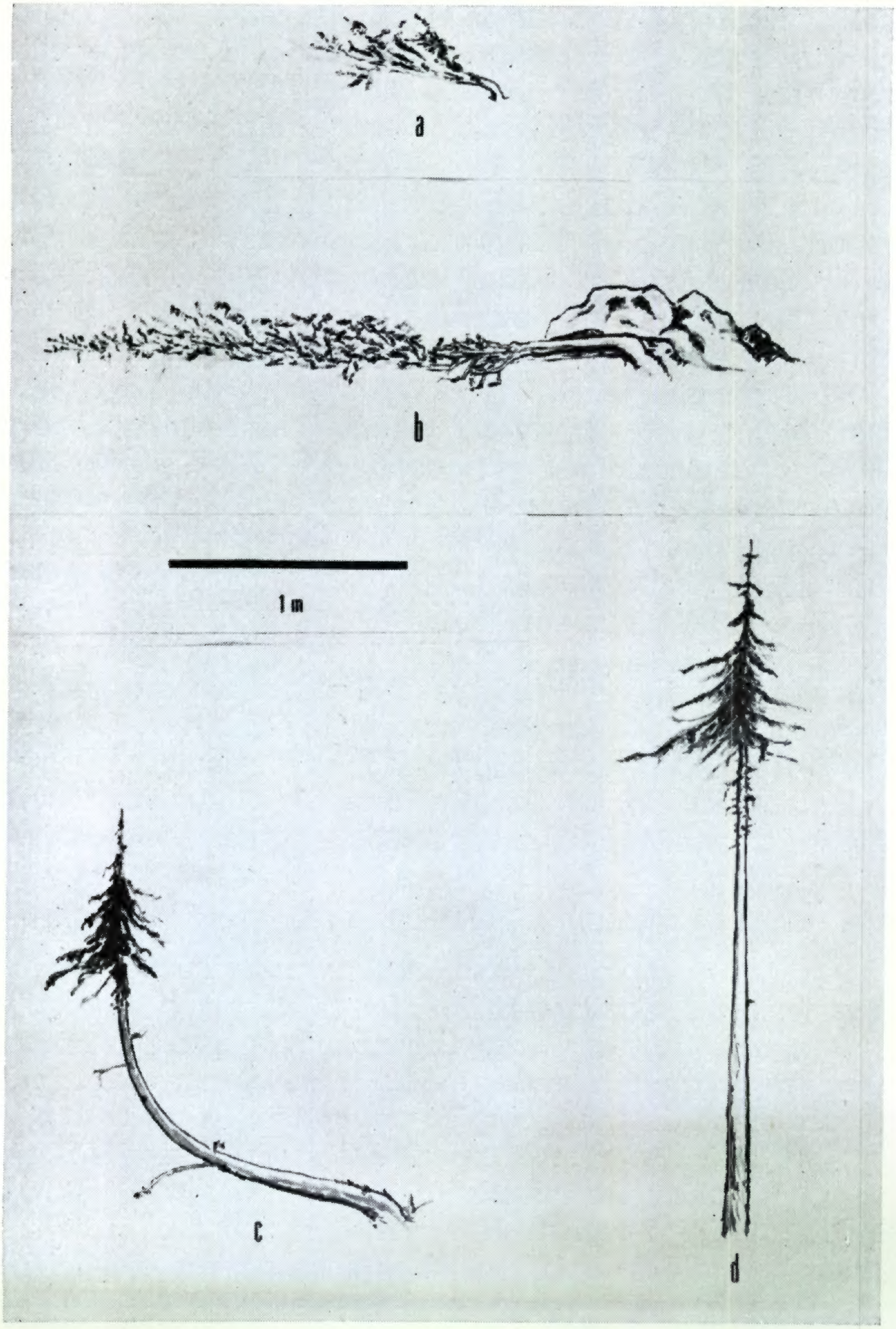
Fig. 1. The growth forms of black spruce in the mountains of New England. a. Vegetative derivative of var. *semiprostrata*. b. A typical plant of var. *semiprostrata* above treeline on Mt. Washington. c. Partially-upright form of long-needled black spruce from below treeline. d. An upright tree of black spruce from several hundred feet below treeline.


a
b
1 m
c
d

needle length of a given plant can be correlated with its growth form. Each plant has a distinct range of needle size. The most prostrate plants have the shortest needle length, about 4 mm; it is these plants which constitute the var. *semiprostrata*. The cline of needle length does not appear to be related directly to altitude above treeline nor exposure of the site. Frequently, long-needle plants (average needle length ca. 8 mm) occur near the upper altitudinal limit of the species. In several sites, long needled, partially upright plants grow immediately beside quite prostrate plants which have an average needle length less than half that of the larger plants. The colonies appear to be of approximately the same age. The short-needle plants possess considerable vigor and show little evidence of killing back or needle damage. Longer needled plants often show needle damage and winter injury. The complex series of plants of intermediate morphology and winter resistance suggests hybridization as the most likely explanation for the cline of types. The genetic extremes of this cline must be the long-needled upright trees and the short-needled prostrate plants. The great number of individuals, each slightly distinct from the others in growth form and needle length suggests a polygenic mechanism of inheritance.

Sexual reproduction of black spruce is not frequent in the present climatic regime in the subalpine regions of New England (Griggs 1942). Cones appear sporadically and in most years few or no cones are produced above treeline. During the summer of 1967, some scattered black spruce plants in the subalpine zone produced a few cones, most of which were male cones. The same plants produced no cones during the summer of 1968. Seedlings are scarce in the subalpine region. However, it is apparent from the present wide distribution of black spruce types that in the past there has been a good breeding population of subalpine black spruce.

Current geological evidence indicates that the deglaciation of New England took place in an erratic fluctuating

manner (Borns 1963). Borns (1963) has suggested that in late-glacial time, the White Mountains of New Hampshire and adjacent Maine were the center for a late-persisting local ice cap. Late-persisting local ice has been inferred for Mt. Katahdin, Maine (Tarr 1899). If a local ice cap did persist in the White Mountains, then the repopulation of the mountains by many taxa of the present subalpine flora could have come from a variety of directions. As habitats became available, suitable plants probably followed the retreating ice closely. Present evidence (Teeri unpub.) suggests that the subalpine black spruce (var. *semiprostrata*) is suited in its ecologic and physiologic requirements to such late-glacial habitats. The var. *semiprostrata*, with short needles, minimal biomass, and a prostrate growth form, is particularly suited to conditions of climate unsuitable for many other woody taxa.

It may be that the evolution of var. *semiprostrata* occurred in the postglacial mountain habitats of its present range. In this case, the taxon may still be in the process of development. Alternatively, the variety may represent the remnants of a population adapted to the environmental conditions at the periphery of the retreating Wisconsin glacier. The late-glacial conditions may well have been similar, near the ice margins, to present environmental conditions in the higher New England mountains. Thus, in the second case, one would not have to postulate the separate evolution of the same taxon in the rather disjunct sites of its present range. Instead the evolution of var. *semiprostrata* could have occurred in a more or less continuous manner, perhaps at the margin of the glaciation. The present range of the variety (i.e. the subalpine regions of northeastern North America) would then be a function of relatively continuous migration and subsequent isolation due to increasingly unfavorable postglacial conditions in the lowlands. As the less winter-resistant red spruce later occupied the mountains, the present mixture of hybrids between black and red spruce (Morgenstern and Farrar 1964) became possible in the middle montane

region. Observations of the past two years have shown an intergradation of many of the characters of the two species just below the treeline on many New England mountains.

The striking difference in needle length and growth form between plants of var. *semiprostrata* and adjacent more typical black spruce, suggests strongly a genetic distinction of the prostrate population. Plants of var. *semiprostrata* are morphologically distinct, possess considerable vigor, and occupy a distinct range. Thus, the category of *varietas* seems to best fit this taxon.

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I thank the following persons for assistance and helpful discussion: A. R. Hodgdon, R. B. Pike, T. S. Teeri. Daniel Sanders prepared the illustrations in fig. 1.

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THE ALSOPHILA SWARTZIANA COMPLEX (CYATHEACEAE).*

RAMÓN RIBA

The genus *Alsophila* R. Brown comprises about 350 species, widely distributed in the tropical and subtropicals regions of the world, with about 150 species in America. This genus can be distinguished from the others of the family, in a traditional sense, by the stem and petioles with scales, and the sori without an indusium or with only a minute scale-like indusium. In a more restricted sense it would include only such species of the traditional genus as have flabelloid petiole scales. The group of *Alsophila swartziana* falls under *Alsophila* in either classification.

I agree with Holttum, (1957), who considers that the morphology of the petiole scales is a character to define natural groups in this family. Holttum recognized two basic types of scales: setiferous scales, with marginal denticulations bicolorous or concolorous with the entire body of the scale, and flabelloid scales, with a margin formed by very fragile cells, very different from the cells of the body of the scale. In the American species of the genera of tree-ferns, however, the structure presented by the petiole scales is more complicated and more diverse than a setiferous type and a flabelloid type.

Maxon (1922) established an informal group of species related to *Alsophila armata* (= *A. swartziana*) based principally on the complete absence of indusium, the degree and type of dissection of the leaf and the pubescence. The South American members of this group were not treated. In the

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*The present paper is a synopsis of "Revisión monográfica del complejo *Alsophila swartziana* Martius (Cyatheaceae)," to be published in An. Inst. Biol. Univ. Nac. Autón. México, 37. Ser. Bot. The research was made possible by a John Simon Guggenheim Fellowship, at the Gray Herbarium, Harvard University, during 1966. The support of the Guggenheim Foundation is gratefully acknowledged. Dr. Rolla Tryon provided helpful guidance during my studies, and field work, in part, was supported by his grant (4184) from the National Science Foundation.

present paper other characteristics of the petiole scales have been used to define the group, in addition to those employed by Maxon, and five species must be excluded from the group: *A. microdonta*, *A. myosuroides*, *A. notabilis*, *A. mexicana* and *A. acutidens*. It includes the American species of *Alsophila* with subflabelloid scales in which the border is more or less differentiated and the margin of the petiole scales of mature leaves or croziers has dark denticulations (fig. 1). The group of *Alsophila swartziana*, then, includes three species of the West Indies, five of Mexico and Central America, four South American species, and a single one of both Central and South America.

KEY TO THE SPECIES

a. Veins of the fertile segments simple, or once forked near the border of the segment; sori borne below the branching of the vein; Jamaica. ..... 1. *A. estelae*

a. Veins of the fertile segments medially forked at least once; sori borne at the branching of the vein. b.

b. Petiole abundantly pubescent, the trichomes sometimes deciduous and then leaving a hard elevated base and a scabrous surface (smooth in *A. swartziana* of the Greater Antilles). c.

c. Paraphyses turgid, persistent, dark red and shorter than the sporangia; Cocos Island. ..... 2. *A. nesiotica*

c. Paraphyses slender, obtuse or acute at the tip, deciduous or persistent, longer than the sporangia. d.

d. Upper surface of the segments with abundant trichomes on the costules, veins and between the veins. e.

e. Margin of petiole scales dark denticulate throughout; apex of pinnules long-attenuate, often curved; Costa Rica to Ecuador. ..... 3. *A. trichiata*

e. Margin of petiole scales smooth or with a few dark teeth apically: apex of pinnules acuminate, nearly straight; Venezuela, Colombia to Bolivia. ..... 4. *A. tryonorum*

d. Upper surface of the segments glabrous or with trichomes only on the costules and veins. f.

f. Upper surface of veins with trichomes (when deciduous the bases evident); mature pinnules with few or no bullate scales along the costa beneath; Mexico to Honduras. g. ..... 5. *A. scabriuscula*

g. Sinuses of segments quadrangular in the basal portion of the pinnules; Mexico, Guatemala, Honduras. .... 5a. var. *scabriuscula*

g. Sinuses of segments acute to rounded in the basal portion of the pinnules; Guatemala. ....5b. var. *guatemalensis*

f. Upper surface of veins glabrous; pinnules beneath with abundant bullate scales along the costa; a flattish scale nearly always present between the costule and the fork of the vein; Jamaica, Haiti and Dominican Republic. ..... 6. *A. swartziana*

b. Petioles glabrous or sparsely pubescent; the trichomes sometimes deciduous and then leaving a prominent scar and a nearly smooth surface. h.

h. Pubescence of lower surface of the costa and costules only of abundant, flexuous, catenate reddish trichomes; eastern Cuba. ..... 7. *A. strigillosa*

h. Pubescence of lower surface of the costa and costules principally of abundant, stiff, terete trichomes. i.

i. Petiole scales with a white body, or with a dark area only at the base; southeastern Brazil. j.

j. Rachis glabrous, prickly with sparse slender spines, slightly hirsute at the apex; segments lanceolate, acute; fertile and sterile veins once forked. ..... 8. *A. hirsuta*

j. Rachis pubescent or subglabrous, unarmed; segments linear, obtuse or acute; fertile and sterile veins with one or two pinnate pairs of veinlets. ..... 9. *A. rufa*

i. Petiole scales, or most of them, with a narrow or broad, dark central stripe and a white border. k.

k. Margin of the petiole scales smooth or with a few dark teeth apically or with a few marginal cells slightly darker than the others; veins impressed above; Colombia to Bolivia. ..... 10. *A. conjugata*

k. Margin of the petiole scales dark denticulate throughout; veins not impressed above. l.

l. Rachis without spines, sometimes slightly muricate; lower surface of costules with flexuous trichomes; upper surface of costules and veins with thin and flexuous trichomes; Costa Rica and Panama. .... 11. *A. stipularis*

l. Rachis with scattered, small, sharp spines; lower surface of costules with stiff trichomes; upper surface of segments glabrous or glabrescent. m.

m. Petiole scales with continuous dark teeth along the margin, with a broad dark central stripe; Guatemala. ..... 12. *A. pansamalana*

m. Petiole scales with whitish cells between the dark teeth along the margin, with a narrow dark central

stripe or sometimes with a dark area at the base; Mexico. ..... 13. *A. bicrenata*

TAXONOMIC AND GEOGRAPHIC NOTES ON THE SPECIES.

1. **Alsophila estelae** Riba, Rhodora 69: 67, *f. 5-7.* 1967.

Type: Mount Horeb, Blue Mountains, Jamaica, *Riba 214* (MEXU); Isotype: (GH)

Alsophila estelae is endemic to Jamaica and is one of the most graceful tree-ferns of that island. At first sight it can be easily confused with *A. swartziana*, a species that grows in the same places. However, the slender trunk (3-4 m tall and ca. 4-6 cm thick) and the crown of small leaves make it a distinctive species in the field. *Alsophila estelae* has been collected only three times in Portland and St. Thomas Parishes.

2. **Alsophila nesiotica** Maxon, Contrib. U. S. Nat. Herb 24: 43. 1922.

Type: Cocos Island, Costa Rica, *Pittier 16229* (US).

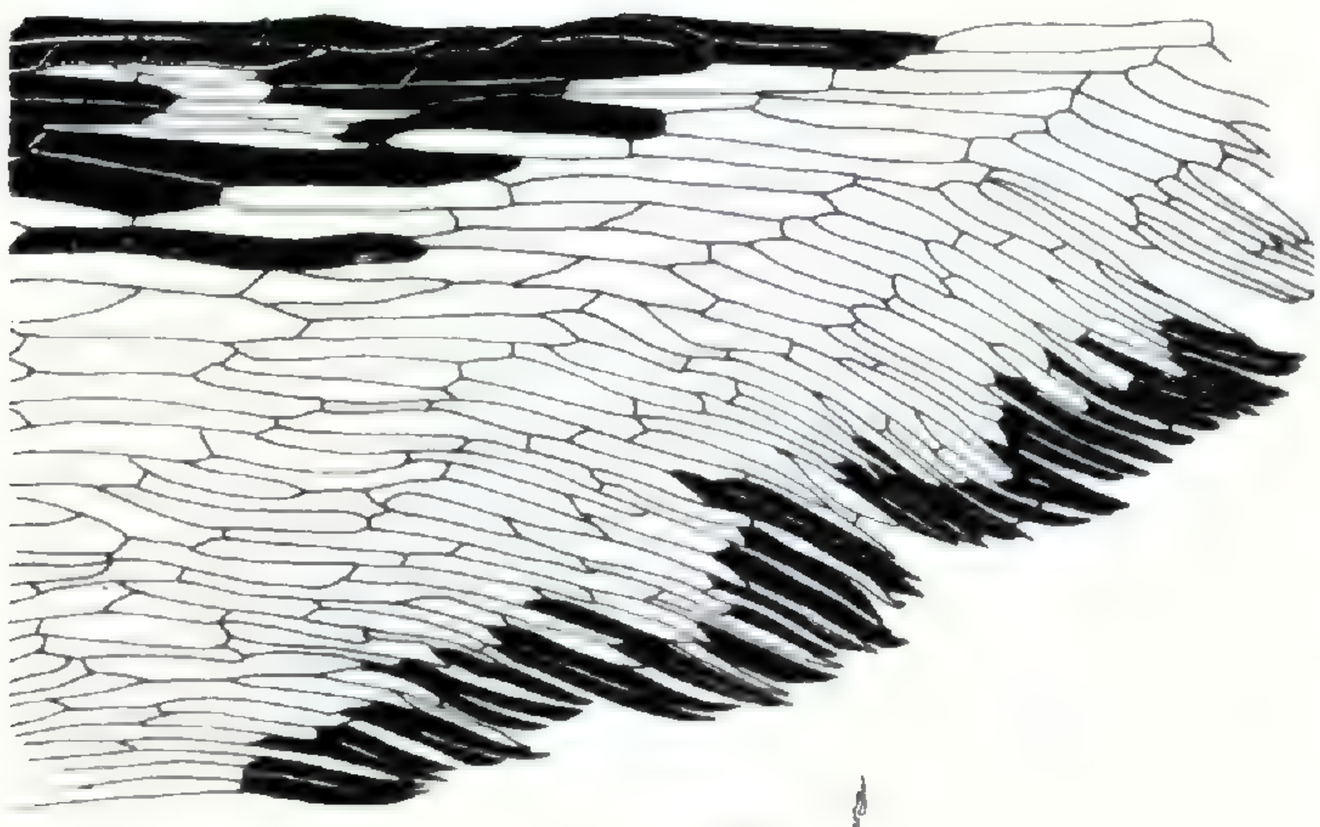
The affinity of *Alsophila nesiotica* with the other species in this group is uncertain. The petiole scales do not have the margin dark denticulate, but the border is well differentiated, its cells are smaller than those of the center and are oriented in a fan-like manner, and a few marginal cells at the apex are slightly darker than the others, without any differentiation in teeth. Material of the croziers has not been available, but it is anticipated that they will have dark denticulate scales, as in *A. conjugata* and *A. tryonorum*.

This species grows only on Cocos Island, Costa Rica, where it has been collected four times.

3. **Alsophila trichiata** Maxon, Contrib. U. S. Nat. Herb. 24: 44, *t. 15.* 1922.

Type: Cana, Panama, *R. S. Williams 928* (US).

Alsophila trichiata (fig. 3) is a species which grows at low elevations, from almost sea level in Costa Rica and Panama and northern Venezuela, up to near 1,000 m of altitude in Ecuador. This species is related to *A. tryonorum*, but that species grows at higher elevations (up to 2,800 m) and



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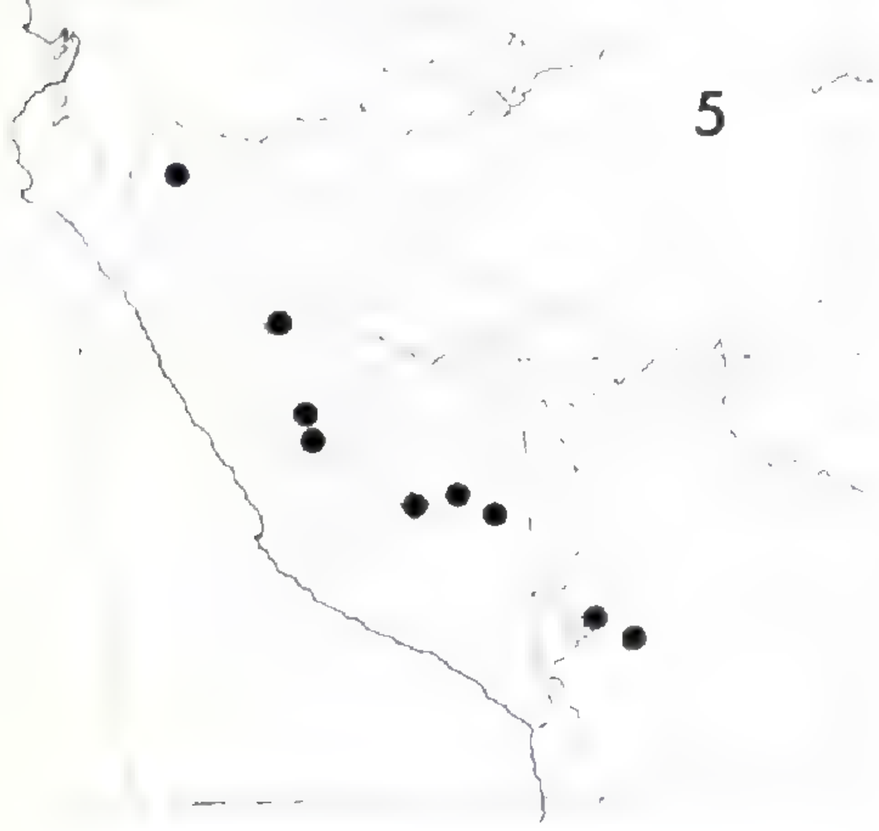

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Fig. 1. Border of petiole scale of *Alsophila trichiata*, × 25. Fig. 2. Winged trichomes from lower surface of costa of *Alsophila pansamalana*, × 40. Fig. 3. Distribution of *Alsophila trichiata*. Fig. 4. Distribution of *Alsophila tryonorum*. Fig. 5. Distribution of *Alsophila conjugata*.

is easily distinguished by characters of the pubescence and the scales given in the key.

4. **Alsophila tryonorum** Riba, Rhodora 69: 66, *f. 1-4.* 1967.

Type: Cuesta de Fusagasugá, Dept. Cundinamarca, Colombia, *Cuatrecasas 8036* (US).

Alsophila tryonorum shows an evident relation with *A. trichiata* because of the similarity of the distribution of the pubescence. However, in *A. trichiata* the rigid trichomes are longer and the catenate trichomes of the petiole are not as abundant as in *A. tryonorum*; the petiole scales in *A. trichiata* have contiguous dark denticulations along the margin, while in *A. tryonorum* the margin has very few dark denticulations or none, except in crozier scales where the dark denticulations are always present. Another relation is with *A. conjugata* based on the similarity of the petiole scales together with the abundant winged trichomes (cf. fig. 2) and bullate scales on the lower surface of the segments. However, the petiole in *A. conjugata* is glabrous, while in *A. tryonorum* it is strongly pubescent with rigid and catenate trichomes.

Alsophila tryonorum (fig. 4) grows in the high mountain forests of northern Venezuela and in the Andean region of Colombia and northern Ecuador.

5. **Alsophila scabriuscula** Maxon, Proc. Biol. Soc. Wash. 32: 125. 1919.

Type: Cubilquitz, Alta Verapaz, Guatemala, *Türckheim* (J. D. Smith Exsicc. *7806*) (US); Isotype (NY).

This species grows in Mexico, Guatemala and Honduras, in the shade of humid tropical forests. Variety **guatemalensis** Riba, Rhodora 69: 68, *f. 8*, 1967 [Type: Sierra de los Cuchumatanes, Dept. Huehuetenango, Guatemala, *Steyermark 49417* (F); Isotype: (US)] is confined to central Guatemala.

The differences between the two varieties are in the sinuses and the size of the leaf. In var. *guatemalensis* the sinuses between the segments are acute to narrowly quadrangular, rather than definitely quadrangular, and the leaf

and its parts are smaller than in var. *scabriuscula*. Although the two varieties occur in the same general region they are distinctive in these characters.

6. **Alsophila swartziana** Martius, Icon. Pl. Crypt. Brasil. 73, *t. 49*. 1834.

Type: based on *Polypodium armatum* Swartz, hence having the same type.

Polypodium armatum Swartz, Prodr. Veg. Ind. Occ. 134. 1788. Type: Jamaica, *Swartz* (S-PA), photograph and fragment (US).

Alsophila armata (Swartz) Presl, Tent. Pterid. 62. 1836, not *A. armata* Martius, 1834.

Alsophila swartziana is confined to Jamaica, Haiti and Dominican Republic; specimens identified as this species, from Venezuela and Brazil prove to be *A. tryonorum* in Venezuela and *A. hirsuta* in Brazil. *Alsophila swartziana* is closely related to *A. bicrenata*, but that species has the upper surface of the segments glabrous, and the petiole smooth; it also has a close relation to *A. scabriuscula* var. *guatemalensis*, but that variety does not have the characteristic scales between the receptacle of the basal sori and the costule.

7. **Alsophila strigillosa** Maxon, Contrib. U. S. Nat. Herb. 24: 37, *t. 11*. 1922.

Type: Nima-nima, eastern Cuba, *C. Wright 1062* (YU), fragment (US); Isotype: (GH).

This species has been collected only twice in eastern Cuba. I have been able to examine several sheets of the type collection; besides this, Maxon cites one sheet, *Wright 891* in the Eaton Herbarium (YU), as containing one pinna of *Cyathea arborea* and one pinna of *A. strigillosa*.

Alsophila strigillosa is one of the best defined species of the *Alsophila swartziana* group, as brought out by the characters given in the key. It seems to be related to *A. swartziana* by the similarity of the scale border and margin, and the pubescence of the upper surface of the segments, with just a few stiff hairs on the costule.

8. **Alsophila hirsuta** (Presl) Kunze, Linnaea 9: 98. 1834.

Cyathea hirsuta Presl, Delic. Prag. 190. 1822. Type: Corcovado, Río de Janeiro, Brazil, *Pohl* (PR or PRC), fragment (NY).

Alsophila hirta Kaulfuss, Enum. Fil. 249. 1824, *ex char.*

This species is known only from Brazil, in some areas of the states of Minas Geraes, Rio de Janeiro, Guanabará, and São Paulo. It is closely related to *A. rufa,* of the same region, differing from the latter by the characters given in the key.

9. **Alsophila rufa** Fée, Crypt. Vasc. Brasil. 1: 165, *t. 39, f. 1.* 1869.

Type: Río de Janeiro, Brazil, *Glaziou 2291* (P).

Alsophila rufa occurs in the same region of Brazil as *A. hirsuta.* The two have sometimes been confused, even considered as the same species, but they are clearly distinct.

10. **Alsophila conjugata** Spruce ex Hooker & Baker, Syn. Fil. 37, 1866.

Type: Chimborazo, Ecuador, *Spruce 5745* (K), fragment (US).

This species (fig. 5) is exclusively Andean in distribution, and is the most widely distributed species in the group; it grows from northern Colombia to Bolivia, always in damp forests, ravines, creeks, or along streams, with an altitudinal distribution which varies from 650 m in Peru to 2,800 m in Colombia.

11. **Alsophila stipularis** Christ, Bull. Herb. Boiss. II, 4: 958. 1904.

Type: Costa Rica, *Wercklé* (P); Isotype: (US).

Alsophila stipularis grows in the higher mountain regions of Costa Rica and Panama between 1000 and 2000 m. This species seem to be related to *A. conjugata* by the glabrescence of the principal axes of the leaf (petiole, rachis and secondary rachises). The petiole scales, however, are different, having a dark denticulate margin with contiguous dark teeth while in *A. conjugata* the dark teeth are nearly lacking.

12. **Alsophila pansamalana** Maxon, Contrib. U. S. Nat. Herb. 24: 40. 1922.

Type: Pansamalá, Alta Verapaz, Guatemala, *Türckheim* (J. D. Smith Exsicc. *1008*) (US).

This species is confined to Guatemala, between 1000 and 2000 m; there is no indication on the collections I have seen concerning the habitat. Its closest relative apparently is *A. scabriuscula* from which it is readily distinguished by its freely armed, glabrous (rather than the scabrous) rachis. The winged trichomes, developed in several species, are illustrated in fig. 2 from the lower surface of a segment.

13. **Alsophila bicrenata** (Liebmann) Fournier, Mex. Pl. Crypt. 134. 1872.

Cyathea bicrenata Liebmann, Dansk. Vid. Selsk. Skrift. V, 1: 289. 1849.

Type: between Trapiche de la Concepcion and Totontepec, Oaxaca, Mexico, *Liebmann* (C), photograph (US); Isotype: (US).

This species is confined to Mexico, from Veracruz to Guerrero, south to Chiapas. It grows in the shade of humid tropical forest, between 1000 and 2000 m.

Alsophila bicrenata is closely related to *A. scabriuscula* var. *scabriuscula;* the petiole scales in both taxa have the same general structure and the habit is very similar. *Alsophila bicrenata* has a glabrous or slightly pubescent petiole, the lower surface of the veins is without long trichomes, and the sinuses between segments are acute or rounded, it has the persistent bullate scales at the base of the costules beneath, these sometimes covering the basal half of the costule.

DISCUSSION.

The differences between the species included in this group are largely in microscopic characteristics, because their gross morphology does not seem to offer characters of specific value. In the whole family, the habit and general morphology are very similar, with a few exceptions. In the

species of the *Alsophila swartziana* group the principal differences are in the type of pubescence and place of attachment of the trichomes. In one species, *Alsophila nesiotica*, the paraphyses are distinctive; in another, *Alsophila estelae*, the venation is distinctive; and in two South American species, *Alsophila conjugata* and *A. tryonorum*, the petiole scales lack the usual dark denticulations on the margin.

The concept of species adopted in this paper is derived from closely related sympatric species in four areas: *Alsophila swartziana* and *A. estelae* in the Greater Antilles, *A. scabriuscula* var. *scabriuscula* and *A. bicrenata* in southern Mexico, *A. tryonorum* and *A. conjugata* in the Andean region, and *A. hirsuta* and *A. rufa* in Brazil. There is no morphological continuity between these species, in each region, and I consider each one of the pair to represent a good species.

To define the distributional center of the group, it is necessary to look for the more primitive species, or at least the less evolved ones. The principal characteristics which are considered as primitive in this group are: a pubescent petiole, a less differentiated border on the petiole scales, and a petiole scale margin without dark denticulations. Accordingly, the most primitive species are the Andean *Alsophila conjugata* and *A. tryonorum*, the latter presenting the most primitive characteristics. *Alsophila trichiata*, Central America to Ecuador, is at about the same evolutionary level.

I suppose, in a purely speculative way, that the distributional center of the species is in the Andean region, an area with many other species of tree-ferns. From this region the migration evidently proceeded north through Central America to Mexico and east to the Antilles. The Antillean species probably were derived from the principal stem which gave rise to the Mexican species. The sympatric groups found in Brazil probably derived from the species of the Andean region, which now has its austral limit in the Bolivian mountains. In regard to *Alsophila nesiotica*, the endemic species

on Cocos Island in the Pacific Ocean, it could be derived from the group represented by *Alsophila trichiata* on the western slope of the Andean region.

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FLORA OF MONOMOY ISLAND, MASSACHUSETTS

EDWIN T. MOUL[1]

The flora of Monomoy Island, Massachusetts, has been investigated during the summers of 1965, 1966, and 1967 in July and August as part of the Systematics-Ecology Program of the Marine Laboratory at Woods Hole. This is part of the survey of the plants of the marine fringe being made for the Cape Cod area under that program.

Monomoy Island is a large mass of sand, one-quarter to one mile wide, built up by shore-drifting from the northern shores of the Cape. It extends into Nantucket Sound for 8 miles, south of Chatham. At present it is under the administration of the Bureau of Sport Fisheries and Wildlife and is reserved as a Wild Life Refuge. The island is built up of a number of curving sand ridges which have become connected by wind-formed dunes. Several natural fresh water ponds and marshes have developed in the hollow of some of the dunes. A number of artificial ponds have been dug by the Bureau of Wildlife to provide food and resting places for migratory wild fowl.

The survey of the island was made by a group of associates from the Systematics-Ecology Program from the laboratory, including Mr. Peter Schwamb, curator of the Gray Museum. We were assisted by Mr. Dana Eldridge, a native of Orleans, Massachusetts. Three areas were covered as completely as possible by doubling back and forth across the island. Herbarium specimens were collected and deposited in the Herbarium of the Gray Museum at the Marine Laboratory, with duplicates placed in the Chrysler Herbarium at Rutgers, The State University, New Jersey.

The areas surveyed were as follows: Area #1 at the southern tip of the island, known as Monomoy Point, around Big Station Pond and Powder Hole. This is an area of dunes, brackish ponds, and fresh water marshes; Area

[1]Systematics-Ecology Program Contribution #155, supported in part by a grant from the Ford Foundation to Systematics-Ecology Program, Marine Biological Laboratory.

#2 was north of this around the Old Monomoy Light Tower and the abandoned Coast Guard Station; Area #3 was at Inward Point and around Hospital Pond. North of Inward Point the island is completely covered with typical dune vegetation.

The flora of islands change over the years. Examination of the records of the flora of Penikese Island (Jordan 1874, Lewis 1924, Fogg 1930, Moul 1948, Moul 1961) will show some drastic changes over the years. So the list of species presented here should be considered the summer flora of Monomoy Island at the present time. A number of plants reported for Monomoy Island by S. G. Cross and C. E. Cross in 1954 (unpublished list provided by Mrs. Marcia G. Norman) were not found. Some of the plants included in this 1954 list are possible misidentifications, since a number of them do not occur in the range of Gray's Manual. *Arctostaphylos uva-ursi*, *Kalmia angustifolia* and *Chrysanthemum leucanthemum* listed as present by Cross and Cross cannot be conspicuous members of the flora, since they were not found even after extensive search in 1967. Moul noted (1961) that *Chrysanthemum leucanthemum*, formerly common on Penikese Island has become extremely rare.

The dominant vegetation type of the island is the dune grass community *(Ammophila breviligulata)* on the primary dunes. With the grass are the usual associates *Lathyrus japonicus*, *Solidago sempervirens*, and *Xanthium echinatum*. This community occupies the whole northern end of the island and the east and west shores. The secondary dunes have dune grass on them, but are principally covered with a *Hudsonia-Cladonia* association. *Artemisia caudata*, *Chrysopsis falcata*, and *Lechea maritima* are commonly associated with *Hudsonia*. These secondary dune communities are very extensive in the Inward Point area and the area around the Monomoy Light Tower. The inner dunes at Monomoy Point (area #1) are covered with a growth of *Ammophila* and *Phragmites communis*. Thickets typical of the main Cape, consisting of *Myrica pensylvanica*, *Rosa rugosa*, *Prunus maritima*, and *Rhus radicans*, occur in the protected hollows and slopes of the inner dunes.

Beach vegetation on the Nantucket Sound or west coast of the island is typical of the Cape beaches. *Cakile edentula*, *Xanthium echinatum*, *Lathyrus japonicus*, and *Atriplex arenaria* are the principal plants of the association. This community is missing on the east or ocean shore.

Extensive cat-tail *(Typha)* marshes occur north of Big Station Pond at Monomoy Point (area #1). *Typha angustifolia* forms a dense phalanx, beneath which grows *Galium palustre*, *Ptilimnium capillaceum*, and *Pluchea purpurascens* in dense stands. The waterways, probably made by muskrats, are filled with *Ludwigia palustris*.

The wet depressions at Monomoy Point and the Lighthouse area have *Festuca rubra* and *Spartina patens* in them. The other species associated with the grasses are *Polygonum* spp., *Rumex crispus*, *Lycopus americanus*, *Scutellaria epilobiifolia*, *Teucrium canadense*, and *Iris versicolor*. This type of vegetation is also found along the shores of the many artificial ponds. Cat-tails and *Onoclea sensibilis* also occur along the shores of some of these ponds. The sand removed in digging the ponds has been piled into artificial dunes, which are now covered with *Rhus radicans*, *Myrica pensylvanica* and *Prunus maritima*.

In the center of the island at area #2 are a few small thickets made up of *Salix discolor*, *Amelanchier laevis*, *Vaccinium corymbosum*, and *Prunus serotina*, with dense margins of *Myrica pensylvanica*. A few *Pinus rigida* grow in the protection of these thickets. The shrubs and trees here show wind pruning due to salt spray.

A number of bogs occur in depressions of the dunes in area #2. *Vaccinium macrocarpon* and *Sphagnum palustre* form the dense ground cover. *Viola lanceolata*, *Lycopodium inundatum*, *Drosera rotundifolia*, and *Pogonia ophioglossoides* grow in these bogs. *Polytrichum commune* occurs around the drier margins of the bogs.

The weedy species such as *Daucus carota*, *Phytolacca americana*, and *Achillea millefolium* are confined principally to the area of the lighthouse and abandoned Coast Guard station, showing the influence of man.

The most mature vegetation occurs at Inward Point (area

#3). This part of the island has been used for years by summer visitors and a number of old cottages are located here. What probably was formerly a fresh water pond, and still may be flooded during wet summers, is dotted with hummocks of *Juncus effusus*. *Ptilimnium capillaceum*, *Hypericum virginicum*, *Osmunda cinnamomea*, and *Iris versicolor* form a dense cover in the wet bottom. A few patches of open water persist. *Dicranum scoparium* grows in the drier portions of the marsh along the border. The thicket surrounding this marsh is quite dense and contains most of the woody species reported for the island. *Vaccinium corymbosum* is very common, and in the summer of 1965 bore a prolific crop of berries, but had no fruit in 1966 or 1967. *Pinus sylvestris* has apparently been planted here in the thickets, and the trees have produced cones regularly.

The largest typical New England type salt marsh occurs north of Inward Point. It is dissected by creeks, and there are a number of dry "pannes" in which scattered *Salicornia* spp., and *Plantago oliganthos* grow. This marsh extends almost completely across the island and merges with the dune grass of the eastern dunes.

Nomenclature used in the list of higher plants is that of Fernald (1950). Nomenclature for the mosses is that of Grout (1940). The assistance of Dr. David Fairbrothers and Mary Hough in identification of a number of taxa is acknowledged.

LICHENS

Cladonia sylvatica (L.) Hoffm. Bare sandy areas on dunes, between vegetation. Areas #1, #2.

Cladonia sp. Between *Hudsonia* plants on dunes near center of island. Area #3.

BRYOPHYTES

Dicranum scoparium Hedw. Path around fresh water marsh in thickets. Area #3.

Polytrichum commune L. var. *perigoniale* (Mx.) Bry. Eur. Carpeting areas around edge of sphagnum-cranberry bogs. Area #2.

Sphagnum palustre L. In the bogs. Area #2.

VASCULAR PLANTS

Lycopodium inundatum L. Fairly common in sphagnum bogs in the hollows of dunes in Area #2.

Osmunda cinnamomea L. Fresh water marsh in Area #3. Inward Point.

Dryopteris thelypteris (L.) Gray. var. *pubescens* (Lawson) Nakai. Commonest fern. Beneath cat-tails in Area #1. Also around artificial ponds and fresh water marshes in areas #2 and #3.

Onoclea sensibilis L. Fairly common. In cat-tail marsh, around artificial ponds and bogs in Areas #1 and #2.

Juniperus virginiana L. Small trees to 2 feet in height around abandoned lighthouse. Area #2.

Pinus rigida Mill. A few low scrubby trees in the center of the island, Area #2. Frequently protected by willow and shad-bush thickets.

Pinus sylvestris L. Planted around a fresh water marsh. In thickets. Cones present. Inward Point. Area #3.

Typha angustifolia L. Very common in low marshy area between dunes. Monomoy Point. Area #1.

Ruppia maritima L. In brackish water ponds near Monomoy Point. Covered with blue-green algae. Area #1.

Triglochin maritima L. In the *Spartina patens* zone of the salt marsh. Inward Point. Area #3.

Agrostis alba L. var. *palustris* (Huds.) Pers. Drier parts of the hollows between dunes and ponds. Area #1, and at the edge of salt marsh and dunes at Inward Point, area #3.

Agrostis scabra Willd. Shade of willow thicket. Center of island. Area #2.

Ammophila breviligulata Fern. Common grass of all dune areas.

Bromus tectorum L. Bare sandy spots in center of island near cottages. Inward Point. Area #2.

Elymus virginicus L. var. *halophilus* (Bickn.) Wieg. Very common at edge of salt marsh and dunes. Upper beach next to dunes. Inward Point. Area #2.

Festuca rubra L. Wet swale, area #1. Edge of cranberry bog, area #2.

Panicum virgatum L. Border of fresh water marsh and dunes, area #1. Dunes and marsh border, east side of island, area #3.

Phragmites communis Trin. Very common around brackish ponds, on dunes, and in swales. Monomoy Point, area #1.

Spartina alterniflora Loisel. Brackish pond, area #1. Salt marsh in area #3.

Spartina patens (Ait.) Muhl. Drier part of swale, area #1. Salt marsh in area #3.

Carex comosa Boott. Wet area in center of island, area #2.

Carex longii Mackenzie. Swale near brackish ponds. Fairly common at other places in the dunes, area #1.

Cyperus grayii Torr. Bare sandy area between *Hudsonia* dunes, area #1. Dunes on east side of island, Inward Point, area #3.

Eleocharis halophila Fern. & Brack. Swale on border of fresh water ponds, area #1.

Eleocharis parvula (R. & S.) Link. Edge of brackish ponds. Very common, area #1.

Eriophorum virginicum L. Wet area in hollow of dunes, area #2.

Scirpus americanus Pers. Swale, border of brackish ponds, area #1. Dune-marsh transition zone, east side of island. Inward Point, area #3.

Scirpus cyperinus (L.) Kunth. Marsh area north of brackish ponds, area #1. Wet thickets in middle of island, area #2.

Juncus acuminatus Michx. Wet area near brackish ponds, area #1.

Juncus effusus L. In fresh water marsh. Inward Point, area #3.

Juncus gerardi Loisel. Salt marsh. Inward Point, area #3.

Juncus greenei Oakes & Tuck. Wet area near brackish ponds, area #1. Sandy soil, hollow of dunes, area #2.

Smilacina stellata (L.) Desf. var. *crassa* Vict. Small plants. In path cut through thickets around fresh water marsh, area #3.

Smilax rotundifolia L. Tangle on shrubs of thickets, area #3.

Iris versicolor L. Around artificial ponds in area #2. In fresh-water marsh at Inward Point, area #3.

Sisyrinchium angustifolium Mill. Around fresh-water ponds, area #2.

Pogonia ophioglossoides (L.) Ker. In sphagnum-cranberry bog between dunes in area #2. Fruiting.

Salix discolor Muhl. Forming small thickets, center of island in area #2. Identified by David Fairbrothers.

Myrica pensylvanica Loisel. Very common in thickets, area #1. Also present in areas #2 and #3.

Polygonum pensylvanicum L. In swale, bordering brackish water ponds, area #1.

Polygonum punctatum Ell. var. *leptostachyum* (Meisn.) Small. Fairly common in swale bordering brackish ponds, area #1. Also bordering fresh-water ponds, center of island in area #2.

Rumex acetosella L. Beach in area #1. Path in thickets in area #3.

Rumex crispus L. Wet area back of dunes bordering brackish ponds in area #1.

Rumex maritimus L. var. *fueginus* (Phil.) Dusen. Small plants growing in belt around brackish pond, just above water level, area #1.

Atriplex arenaria Nutt. Beach vegetation, areas #1 and #3. Flowers and seeds.

Atriplex patula L. var. *hastata* (L.) Gray. Dominant in beach vegetation, area #1.

Salicornia bigelovii Torr. Bare areas in salt marsh, area #3.

Salicornia europaea L. Salt marsh. "Pannes" and in *S. patens* zone, area #3.

Salicornia virginica L. Salt marsh. "Pannes" and in *S. patens* zone, area #3.

Suaeda maritima (L.) Dumort. Edge of salt marsh, area #3.

Salsola kali L. Dominant on beach, area #1.

Phytolacca americana L. Around Monomoy Light Tower, area #2.

Arenaria peploides L. var. *robusta* Fern. Beach on ocean side, area #3.

Dianthus armeria L. In thickets of bayberry, between fresh-water marsh and dunes, area #1.

Spergularia marina (L.) Grisch. In sand at edge of brackish ponds in area #1. Bare area in salt marsh, area #3.

Nymphaea odorata Ait. In fresh-water ponds (artificial), area #2.

Cakile edentula (Bigel.) Hook. Beach, area #1.

Lepidium virginicum L. Along edge of brackish ponds, higher ground at edge of bayberry thickets, area #1.

Drosera rotundifolia L. Sphagnum-cranberry bogs between dunes. Area #2.

Amelanchier laevis Wieg. Common in thickets in center of island. Areas #2 and #3.

Potentilla egedei Wormsk. var. *groenlandica* (Tratt.) Polunin. Fairly common in *Juncus gerardi* zone of salt marsh, area #3.

Prunus maritima Marsh. A common component of thickets in center of the island and around fresh-water and brackish water ponds. Areas #1, #2, and #3.

Prunus persica (L.) Batsch. In a hedge, along side abandoned house at lighthouse, area #2.

Prunus serotina Ehrh. Part of dune thickets, center of island. Areas #2 and #3.

Pyrus arbutifolia (L.) L.f. Thickets in center of island and around fresh-water marsh. Areas #2 and #3.

Rosa carolina L. Thickets along road in dunes, area #3.

Rosa nitida Willd. Roadside and dune, area #3.

Rosa rugosa Thunb. Dunes and thickets. Areas #1 and #2.

Rubus hispidus L. Trailing in path through thickets around fresh-water marsh.

Rubus idaeus L. var. *strigosus* (Michx.) Maxim. Thickets along roadsides and dunes. With *Rhus radicans*. Fruits. Area #3.

Spiraea tomentosa L. Edge of sphagnum-cranberry bog. Area #2.

Lathyrus japonicus Willd. Part of beach vegetation and frontal dunes. Very common. Areas #1, #2, & #3.

Euphorbia polygonifolia L. Plants on beach, smaller ones in dunes. Area #1.

Rhus radicans L. Very common. In thickets, back of dunes. Areas #1, #2, and #3.

Ilex verticillata (L.) Gray. Thickets, tops of dunes in center of island, area #3.

Hypericum boreale (Britt.) Bickn. Dry area between fresh-water marsh and dunes, area #1.

Hypericum virginicum L. Wet area between dunes, area #2. Fresh-water marsh at Inward Point, area #3.

Hudsonia tomentosa Nutt. Very common on secondary dunes. All areas.

Lechea maritima Leggett. Scattered over dunes in area #3.

Viola lanceolata L. Sphagnum-cranberry bog in hollow of dunes. Area #2.

Ludwigia palustris (L.) Ell. var. *americana* (DC) Fern. & Grisc. Very abundant in fresh-water marsh, area #1.

Daucus carota L. Weedy area around old lighthouse station, area #2.

Ptilimnium capillaceum (Michx.) Raf. Wet areas near brackish and fresh-water marshes and ponds, areas #1 and #2.

Lyonia ligustrina (L.) DC. Part of thickets around fresh-water marsh, area #3.

Vaccinium angustifolium Ait. var. *nigrum* (Wood) Dole. Thickets on dune top, center of island, area #3.

Vaccinium corymbosum L. Thickets around fresh-water marsh. Fruit abundant 1965, none in 1966 and 1967, area #3.

Vaccinium macrocarpon Ait. Small plant in wet swale in area #1. Abundant in several bogs in hollow of dunes, area #2.

Trientalis borealis Raf. Sandy soil, in path and under thickets around fresh-water marsh. Area #3.

Limonium carolinianum (Walt.) Britton. Bare areas and in *Spartina patens* zone of salt marsh. Area #3.

Lycopus americanus L. Wet area around brackish ponds. Area #1.

Scutellaria epilobiifolia Hamilton. Common around edges of artificial fresh-water ponds. Area #2.

Teucrium canadense L. Common around artificial fresh-water ponds. Area #2.

Linaria canadensis (L.) Dumont. Sandy soil on dunes. Flowering over and seed formed. Area #3.

Linaria vulgaris Hill. Depression in dunes near west shore. Not blooming. Area #3.

Verbascum thapsus L. Edge of a depression near fresh-water ponds. Area #1.

Plantago oliganthos R. & S. Bare area in salt marsh. Area #3.

Galium palustre L. Wet area near brackish ponds. Very common. Area #1.

Viburnum dentatum L. Thickets around fresh-water marsh. Area #3.

Achillea millefolium L. Weedy area around old lighthouse, area #2.

Artemisia caudata Michx. Common on dunes. Better developed in center of island. Areas #1 and #2.

Artemisia stelleriana Bess. Beach vegetation. Area #1.

Aster sp. Near old lighthouse. Area #2.

Baccharis halimifolia L. Low dunes and high part of salt marsh. Area #3.

Chrysopsis falcata (Pursh.) Ell. Very common on dunes in all areas. In 1965 attacked and defoliated by caterpillars.

Cirsium vulgare (Savi) Tenore. Edge of bayberry thickets near brackish ponds, area #1.

Erichtites hieraceifolia (L.) Raf. Weedy area around old lighthouse. Wet area. Area #2.

Gnaphalium obtusifolium L. Between dunes and brackish ponds. Area #1.

Pluchea purpurascens (Sw.) DC. var. *succulenta* Fern. Swale at border of brackish water ponds in *Typha* marsh, area #1.

Solidago sempervirens L. Beach and dunes. Areas #1, #2, and #3.

Solidago tenuifolia Pursh. Between dunes and near freshwater ponds, area #2. Between dunes and salt marsh, area #3.

Sonchus asper (L.) Hill. Edge of pond and thickets. Area #1.

Xanthium echinatum Murr. Beach and dunes. Areas #2 and #3.

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A FLORISTIC AND ECOLOGICAL STUDY OF PITCHER PLANT BOGS IN SOUTH MISSISSIPPI

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An interest in the effects of fire on the vascular flora of pitcher plant bogs led to a floristic and ecological study of such bogs in south Mississippi. This included the intensive comparison of a peaty bog, which had been burned annually in the winter for the past seven years, with a similar bog which had not been burned for three years. The study area is located in Harrison County, Mississippi, northwest of Gulfport and approximately six miles from the Gulf Coast, and on the southern edge of the Southern Pine Hills. The bogs occupy a position between the hilltop pine forest and the bottomland forest along Bayou Bernard. The two bogs that were studied are both open with a few scattered pine and cypress trees. The soil is an acid, Portmouth, sandy loam with a high organic matter content. The bogs in this area appear to have been only slightly disturbed by the activities of European man.

The ecological aspects of this study are reported in detail in Eleuterius (1968); however, some of our conclusions, observations, and hypotheses are briefly summarized in this paper. We do not suggest that our observations have not been previously noted, but we feel that they should be mentioned here. Pitcher plant bogs have been discussed in a number of papers including Garren (1943), Harper (1906), Plummer (1963 and 1966), and Wells (1928). Since the earlier report by Harper (1906), there have been changes in the vascular flora of pitcher plant habitats in Georgia due to the disturbance of these ecosystems. These changes were described by Pullen and Plummer (1964). We believe that *Sarracenia alata* is dependent upon fire to maintain the open bog, as are a number of our native bog orchids. In the burned bog, *Sarracenia alata* was more vigorous, with both larger leaves and rhizomes; while in the absence of fire *Sarracenia alata* tends to decrease in abundance. The addition of 6-12-12 fertilizer

(1 lb/100 sq. ft.) and ammonium nitrate (2 lb/100 sq. ft.), divided into two applications each, caused a decrease in *Sarracenia alata*. The bogs are not deficient in N-P-K as some have suggested; however, the amount of N-P-K decreased during the growing season. The nutrient levels in pounds per acre were: N, April 90, September 18; P, April 160, September 140; K, April 150, September 100. Plant succession on the bogs was toward a "sedge-woody species" dominated community. Fire, however, retards this succession, and we believe that the pitcher plant community is a "fire type" vegetation. Clip-quadrat studies pointed out that fire increases plant productivity. The greatest number of species were found in the burned bog, while the unburned bog was dominated by sedges, with a reduction in the total number of species. Although plants are in flower from March to November, there are two major phenological peaks, one in June and one in August.

The unique floral beauty and composition of the bogs make them of scientific and aesthetic importance. These ecosystems, however, are in danger of being destroyed by man's activities; such as, the expansion of suburban and industrial complexes northward from the coast, and the draining of the bogs and the planting of pine by public and private interests.

A phylogenetic list of the plant species is presented below. The phylogenetic arrangement and nomenclature generally follows that of Radford, *et al.* (1964), although Small (1933) and Hitchcock and Chase (1950) were also used in identification. Species not considered characteristic of bogs were also collected because they were present within the bogs due to slight alteration of the ecosystem by either man, ant hills, crayfish, or slight elevations or depressions. They are indicated by an asterisk (*) in the phylogenetic listing.

We would like to thank several individuals for their help with the project, including: Drs. Ben Channel, Robert Kral, and Sidney McDaniel, and Mr. F. H. Sargent. The

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PHYLOGENETIC LIST OF THE TAXA:

LYCOPODIACEAE — *Lycopodium alopecuroides* L., *L. adpressum* (Chapm.) Lloyd & Underw., *L. carolinianum* L., *L. prostratum* Harper.

OSMUNDACEAE — *Osmunda cinnamomea* L., *O. regalis* var. *spectabilis* (Willd.) Gray.

PTERIDACEAE — *Pteridium aquilinum* (L.) Kuhn.

BLECHNACEAE — *Anchistea virginica* (L.) Presl., *Lorinseria areolata* (L.) Presl.

PINACEAE — *Pinus elliottii* Engelm., *P. palustris* Mill., *P. taeda* L.

TAXODIACEAE — *Taxodium ascendens* Brongn.

POACEAE — *Andropogon glomeratus* (Walt.) BSP., *Anthaenantia villosa* (Michx.) Beauv., *Aristida affinis* (Schult.) Kunth., *A. purpurascens* Poir., *A. stricta* Michx., *Arundinaria gigantea* (Walt.) Muhl., *Ctenium aromaticum* (Walt.) Wood., *Eragrostis spectabilis* (Pursh) Steud., *Manisuris cylindrica* (Michx.) Kuntz., *Muhlenbergia expansa* (DC.) Trin., *Panicum aciculare* Desv. ex Poir., *P. commutatum* Schult., *P. lanuginosum* Ell., *P. leucothrix* Nash., *P. longiligulatum* Nash., *P. repens* L., *P. sphaerocarpon* Ell., *P. verrucosum* Muhl., *P. virgatum* L., *P. wrightianum* Schribn., *Paspalum difforme* LeConte., *P. floridanum* Michx., **P. notatum* Flugge., *P. urvillei* Steud., *Sporobolus junceus* (Michx.) Kunth., *Tridens ambiguus* (Ell.) *Schult., T. strictus* (Nutt.) Nash.

CYPERACEAE — *Carex glaucescens* Ell., *C. lurida* Wahlenb., *C. stylo-flexa* Buckl., *Dichromena colorata* (L.) Hitchc., *D. latifolia* Baldw., *Eleocharis tuberculosa* (Michx.) R. & S., *Rhynchospora caduca* Ell., *R. cephalantha* Gray., *R. chalarocephala* Fern. & Gale., *R. chapmanii* M. A. Curtis., *R. corniculata* (Lam.) Gray., *R. filifolia* Gray., *R. glomerata* (L.) Vahl., *R. gracilenta* Gray., *R. harveyi* W. Booth., *R. inexpansa* (Michx.) Vahl., *R. macra* (Clarke) Small., *R. microcephala* Britt. ex. Small., *R. oligantha* Gray., *R. plumosa* Ell., *R. rariflora* (Michx.) Ell., *R. tracyi* Britt., *Scirpus americanus* Pers., *Scleria baldwinii* (Torr.) Steud., *S. georgiana Core., S. oligantha* Michx., *S. reticularis* Michx.

XYRIDACEAE — *Xyris ambigua* Beyr., *X. baldwiniana* R. S., *X. caroliniana* Walt., *X. difformis* Chapm., *X. fimbriata* Ell., *X. flexuosa* Muhl. ex Ell., *X. iridifolia* Chapm.

ERIOCAULACEAE — *Eriocaulon compressum* Lam., *E. decangulare* L., *E. lineare* Small., *Lachnocaulon anceps* (Walt.) Morong., *L. minus* (Chapm.) Small.

BROMELIACEAE — **Tillandsia usneoides* L.

JUNCACEAE — *Juncus biflorus* Ell., *J. brachycarps Engelm.*, *J. canadensis* J. Gay ex La Harpe., *J. effusus* L., *J. elliottii* Chapm., *J. marginatus* Rostk., *J. scirpoides* Lam., *J. validus* Cov.

LILIACEAE — *Aletris aurea* Walt., *A. farinosa* L., *A. lutea* Small., *Lilium catesbaei* Walt., *Melanthium virginicum* L., *Smilax laurifolia* L., *S. rotundifolia* L., *S. smallii* Morong., *Tofieldia racemosa* (Walt.) BSP., *Zigadenus densus* (Desr.) Fern., *Z. glaberrimus* Michx.

AMARYLLIDACEAE — *Hypoxis micrantha* Pollard.

HAEMODORACEAE — *Lachnanthes caroliniana* (Lam.) Dandy., *Lophiola americana* (Pursh.) Wood.

IRIDACEAE — *Sisyrinchium albidum* Raf.

ORCHIDACEAE — *Calopogon pallidus* Chapm., *C. pulchellus* (Salisb.) R. Br., *Cleistes divaricata* (L). Ames., *Habenaria blephariglottis* (Willd.) Hook., *H. ciliaris* (L.) R. Br., *H. cristata* (Michx.) R. Br., *H. nivea* (Nutt.) Spreng., *Pogonia ophioglossoides* (L.) Ker-Gawl., *Spiranthes praecox* (Walt.) S. Wats., *S. vernalis* Engelm. & Gray.

MYRICACEAE — *Myrica cerifera* L., *M. inodora* Bart., *M. pensylvanica* Loisel.

PHYTOLACCACEAE — **Phytolacca americana* L.

MAGNOLIACEAE — *Magnolia virginiana* L.

LAURACEAE — *Persea borbonia* (L.) Spreng.

SARRACENIACEAE — *Sarracenia alata* Wood & Wood., *S. psittacina* Michx.

DROSERACEAE — *Drosera brevifolia* Pursh., *D. capillaris* Poir., *D. filiformis* Raf., *D. intermedia* Hayne.

SAXIFRAGACEAE — *Itea virginica* L.

HAMAMELIDACEAE — *Hamamelis virginiana* L., *Liquidambar styraciflua* L.

ROSACEAE — **Rubus trivialis* Michx., *Sorbus arbutifolia* (L.) Heynh.

FABACEAE — **Clitoria mariana* L., **Lespedeza capitata* Michx., **Petalostemum pinnatum* (Walt. ex J. F. Gmel.) Blake.

LINACEAE — *Linum striatum* Walt., *L. virginianum* L.

POLYGALACEAE — *Polygala cruciata* L., *P. cymosa* Walt., *P. incarnata* L., *P. lutea* L., *P. mariana* Mill.

EUPHORBIACEAE — **Croton capitatus* Michx., **Euphorbia chamaesyce* L., **E. corollata* L., **E. maculata* L.

ANACARDIACEAE — *Rhus vernix* L.

CYRILLACEAE — *Cliftonia monophylla* (Lam.) Sarg., *Cyrilla racemiflora* L.

AQUIFOLIACEAE — *Ilex coriacea* (Pursh) Chapm., *I. glabra* (L.) Gray., *I. vomitoria* Ait.

ACERACEAE — *Acer rubrum* L.

RHAMNACEAE — *Ceanothus americanus* L.

VITACEAE — **Vitis rotundifolia* Michx.

MALVACEAE — *Hibiscus aculeatus* Walt.
HYPERICACEAE — *Hypericum cistifolium* Lam., *H. denticulatum* H.B.K., *H. fasciculatum* Lam., *H. stans* (Michx.) Adams & Robson.
VIOLACEAE — *Viola lanceolata* L., *V. primulifolia* L.
LYTHRACEAE — *Cuphea carthagensis* (Jacq.) Macbr.
MELASTOMATACEAE — *Rhexia alifanus* Walt., *R. cubensis* Griseb. *R. lutea* Walt., *R. mariana* L., *R. Nashii* Small., *R. virginica* L.
ONAGRACEAE — *Ludwigia hirtella* Raf., *L. pilosa* Walt., **Oenothera fruticosa* L.
HALORAGACEAE — *Proserpinaca pectinata* Lam.
APIACEAE — *Centella asiatica* (L.) Urban., *Eryngium integrifolium* Walt., *E. yuccifolium* Michx. var. *synchaetum* Gray., *Hydrocotyle umbellata* L., *Oxypolis filiformis* (Walt.) Britt.
NYSSACEAE — *Nyssa sylvatica* Marsh., *N. sylvatica* Marsh. var. *biflora* (Walt.) Sarg.
CLETHRACEAE — *Clethra alnifolia* L.
ERICACEAE — *Gaylussacia dumosa* (Andr.) T. & G., *Lyonia ligustrina* (L.) DC.
SYMPLOCACEAE — *Symplocos tintoria* (L.) L'Her.
STYRACACEAE — *Styrax americana* Lam., *S. grandifolia* Ait.
LOGANIACEAE — *Cynoctonum sessilifolium* J. F. Gmel., *Gelsemium sempervirens* (L.) Ait. f., **Polypremum procumbens* L.
GENTIANACEAE — *Sabatia campanulata* (L.) Torr., *S. dodecandra* (L.) BSP., *S. macrophylla* Hook.
ASCLEPIADACEAE — *Asclepias cinerea* Walt., *A. lanceolata* Walt., *A. longifolia* Michx., *A. michauxii* Dcne.
CONVOLVULACEAE — *Cuscuta gronovii* Willd.
POLEMONIACEAE — *Phlox carolina* L., *P. pilosa* L.
VERBENACEAE — *Lippia nodiflora* (L.) Michx.
LAMIACEAE — *Hyptis alata* (Raf.) Shinners., *Lycopus rubellus* Moench., *Scutellaria integrifolia* L., *Trichostema dichotomum* L.
SCROPHULARIACEAE — *Agalinis aphylla* (Nutt.) Raf., *A. purpurea* (L.) Pennell., *Buchnera floridana* Gandoger.
LENTIBULARIACEAE — *Pinguicula caerulea* Walt., *P. lutea* Walt., *Utricularia cornuta* Michx., *U. fibrosa* Walt., *U. juncea* Vahl., *U. subulata* L.
ACANTHACEAE — *Ruellia noctiflora* (Nees) Gray.
RUBIACEAE — *Cephalanthus occidentalis* L., **Diodia teres* Walt., *D. virginiana* L.
CAPRIFOLIACEAE — **Lonicera sempervirens* L., *Viburnum nudum* L.
CAMPANULACEAE — *Lobelia floridana* Chapm., *L. glandulosa* Walt., *L. puberula* Michx.
ASTERACEAE — *Aster dumosus* L., *A. lateriflorus* (L.) Britt., *A. linariifolius* L., *A. paludosus* Ait., *A. pilosus* Willd., *A. reticulatus* Pursh., *A. umbellatus* Mill., *Balduina uniflora* Nutt., *Bidens frondosa* L., *Boltonia asteroides* (L.) L'Her., *B. diffusa* Ell.,

Cacalia lanceolata Nutt., *Carduus lanceolatus* L., *C. lecontei* (T. & G.) Pollard., *C. spinosissimus* Walt., *Carphephorus pseudoliatris* Cass., *Chaptalia tomentosa* Vent., *Chondrophora nudata* (Michx.) Britt., *Coreopsis angustifolia* Ait., **C. lanceolata* L., *C. major* Walt., *C. pubescens* Ell., *Elephantopus elatus* Bertol., **Erechtites hieracifolia* (L.) Raf., **Erigeron canadensis* L., **E. philadelphicus* L., **E. quercifolius* Lam., **E. strigosus* Muhl. ex Willd., *E. vernus* (L.) T. & G., *Eupatorium album* L., **E. capillifolium* (Lam.) Small., *E. coelestinum* L., *E. hyssopifolium* L., *E. leucolepis* (DC.) T. & G., *E. rotundifolium* L., **Helenium amarum* (Raf.) H. Rock., *H. vernale* Walt., *Helianthus angustifolius* L., **H. divaricatus* L., *H. heterophyllus* Nutt., *H. radula* (Pursh) T. & G., *Heterotheca graminifolia* (Michx.) Shinners., *H. mariana* (L.) Shinners., *H. nervosa* (Willd.) Shinners., *Liatris aspera* Michx., *L. elegans* (Walt.) Michx., *L. gracilis* Pursh., *L. spicata* (L.) Willd. var. *resinosa* (Nutt.) Gaiser., *Pluchea rosea* Godfrey., *Rudbeckia hirta* L., *Solidago odora* Ait., *S. petiolata* Mill., *Stokesia laevis* (Hill) Greene., *Trilisa odoratissima* (J. F. Gmel.) Cass., *Vernonia altissima* Nutt.

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THE BROMELIACEAE OF BOLIVIA

LYMAN B. SMITH

Originally this paper was prepared as an integral part of Robert C. Foster's *Flora of Bolivia* and although it is no longer possible to so include it, I am continuing that format in order to relate to his work as closely as possible. Reference to the "Catalogue" is to R. C. Foster, A catalogue of the ferns and flowering plants of Bolivia, Contrib. Gray Herb. **184.** 1958.

a. Seeds appendaged; ovary wholly or partly superior; fruit a capsule.
  b. Appendages of the seeds entire, not plumose; ovary often only partly superior; leaves mostly spinose-serrate; plants almost always terrestrial. ..... Subfamily 1. *Pitcairnioideae.*
c. Filaments not forming a tube; petals free.
  d. Petals twisted together after anthesis, mostly large (13-80 mm.); plants usually large and coarse; leaf-blades narrowly triangular, never narrowed toward base; ovary nearly or quite superior. ..... 1. *Puya.*
  d. Petals free after anthesis.
    e. Ovary wholly superior.
      f. Petals naked, small (3-9 mm.); plants small (25-100 cm.) and delicate; seeds narrow, caudate-appendaged at each pole. ..... 2. *Fosterella.*
      f. Petals each bearing a single large scale at base.
        g. Scape evident, bearing a cambium layer; inflorescence paniculate, perennial; plants shrubby. .... 3. *Deuterocohnia.*
        g. Scape lacking; inflorescences one-flowered, at the ends of the branches; plants low and cushion-forming. .... 4. *Abromeitiella.*
    e. Ovary partly inferior; flowers large and conspicuous, usually zygomorphic; petals often appendaged; seeds winged or caudate. ..... 5. *Pitcairnia.*
c. Filaments forming a tube to which the petals are joined by their centers; petals with their margins free, yellow or orange; seeds winged. ..... 6. *Dyckia.*
  b. Appendages of the seeds plumose; ovary nearly or quite superior; leaves always entire; plants chiefly epiphytic. .... Subfamily 2. *Tillandsioideae.*
    h. Petals free, or if slightly joined then with the corolla-tube deeply included in the calyx; inflorescence of one or more

distichous-flowered spikes or rarely simple and polystichous or even one-flowered.

i. Petals naked. ..... 7. *Tillandsia.*

i. Petals each bearing two scales on the inner surface near the base. ..... 8. *Vriesea.*

h. Petals closely agglutinated and simulating true fusion, the corolla-tube about equaling the calyx or longer; flowers always polystichous. ..... 9. *Guzmania.*

a. Seeds always naked; ovary wholly inferior; fruit always baccate, fleshy to coriaceous; leaves usually spinose-serrate; plants often epiphytic. ..... Subfamily 3. *Bromelioideae.*

j. Petals naked; inflorescence compound.

k. Filaments free from each other; petals free, not fleshy; flowers distichous. ..... 10. *Streptocalyx.*

k. Filaments forming a tube to which the fleshy petals are joined along their centers but with their margins free; flowers polystichous. ..... 11. *Bromelia.*

j. Petals appendaged.

l. Ovaries always remaining distinct; inflorescence compound or simple.

m. Petals straight, mostly small; sepals usually mucronate. .... 12. *Aechmea.*

m. Petals recurved in a tight coil at anthesis, large (5-9 cm.); sepals unarmed. ..... 13. *Billbergia.*

l. Ovaries fused with each other and with the fleshy bracts to form a syncarp; inflorescence with an apical coma, simple.

n. Inflorescence with a small inconspicuous coma, never producing basal shoots; plant propgating by elongate rhizomes; petals bearing vertical folds. ..... 14. *Pseudananas.*

n. Inflorescence with a large conspicuous coma, often with basal shoots; rhizome lacking; petals bearing well developed scales. ..... 15. *Ananas.*

1. **Puya** Molina

Perennial, often long-caulescent, simple or branching, coarse, often flowering several meters high. Leaves densely rosulate, the blades narrowly triangular, usually spinose-serrate with coarse teeth. Inflorescence simple or compound, the branches fertile throughout or with the apical half sterile. Flowers showy, regular. Sepals free, shorter than the petals. Petals free, usually spreading at anthesis, twisted together afterwards, naked or rarely with paired vertical folds. Stamens usually included, the filaments free. Ovary superior or nearly so, glabrous, the style slender, elongate. Capsule primarily loculicidal. Seeds broad, alate.

a. Inflorescence and its branches fertile throughout or nearly so. .... Subgenus 1. *Pitcairniopsis.*

b. Ultimate axes of the inflorescence more or less visible; neither the inflorescence nor its branches strobiliform.
c. Inflorescence compound. ..... *Subkey I.*
c. Inflorescence simple. ..... *Subkey II.*
b. Ultimate axes of the inflorescence completely covered; inflorescence or its branches strobilate (sometimes the flowers or the bracts reflexed but the axis still covered).
d. Inflorescence obviously compound (at least by the lobed outline). ..... *Subkey III.*
d. Inflorescence simple or pseudosimple with the short branches covered by the primary bracts. ..... *Subkey IV.*
a. Inflorescence compound with branches sterile in large part toward apex. ..... Subgenus 2. *Puya.*

Subgenus 1. PITCAIRNIOPSIS

Subkey I

a. Branches of the inflorescence more than twice as long as the primary bracts, divergent to spreading; inflorescence usually broad.
b. Floral bracts coarsely pectinate-serrate. ..... 1. *P. ultima.*
b. Floral bracts entire or nearly so.
c. Sepals sparsely lepidote or glabrous.
d. Branches at least three times as long as the primary bracts.
e. Racemes lax throughout, the rhachis wholly visible.
f. Sepals alate-carinate throughout, even. ..... 2. *P. alata.*
f. Sepals carinate or alate only at base, strongly sulcate when dry in most cases.
g. Pedicels soon glabrous.
h. Floral bracts about equaling the pedicels; pedicels 15-18 mm. long. ..... 3. *P. Hofstenii.*
h. Floral bracts about half as long as the pedicels.
i. Primary bracts about equaling the sterile bases of the branches; sepals lanceolate, 21 mm. long. .... 4. *P. potosina.*
i. Primary bracts much shorter than the sterile bases of the branches; sepals oblong, 15 mm. long. ..... 5. *P. Trollii.*
g. Pedicels persistently vestite.
j. Pedicels 20-25 mm. long; floral bracts oblong-ovate. ..... 6. *P. Rusbyi.*
j. Pedicels 5-15 mm. long; floral bracts broadly ovate or elliptic.
k. Sepals alate at base, 25-32 mm. long. .... 7. *P. cristata.*
k. Sepals not more than angled at base.
l. Leaf-blades tomentose beneath with coarse linear spreading scales; sepals 17 mm. long. .... 8. *P. laxa.*

l. Leaf-blades with subspreading suborbicular scales beneath; sepals 20-28 mm. long. ..... 9. *sanctae-crucis.*

e. Racemes subdense; rhachis only partially exposed at anthesis.

m. Sepals 17 mm. long, scarcely if at all exceeding the floral bracts; pedicels glabrous. ..... 10. *P. Fiebrigii.*

m. Sepals 28-40 mm. long; pedicels tomentose-lepidote.

n. Floral bracts lanceolate, nearly flat. .. 11. *P. Meziana.*

n. Floral bracts ovate, inflated.

o. Primary bracts much shorter than the long, sterile bases of the branches; floral bracts much exceeded by the sepals. ..... 12. *P. secunda.*

o. Primary bracts far exceeding the short, sterile bases of the branches; floral bracts nearly equaling the sepals. ..... 13. *P. stenothyrsa.*

d. Branches little more than twice as long as the primary bracts.

p. Floral bracts lanceolate, attenuate. ..... 14. *P. glareosa.*

p. Floral bracts elliptic, ample, rounded and apiculate.

q. Pedicels to 25 mm. long. ..... 15. *P. olivacea.*

q. Pedicels not over 10 mm. long. ..... 13. *P. stenothyrsa.*

c. Sepals densely and persistently vestite.

r. Indument ferruginous-stellate with stiff-rayed trichomes. .... 16. *P. ferruginea.*

r. Indument obscurely stellate with soft-rayed trichomes.

s. Pedicels over 15 mm. long.

t. Floral bracts drying dark; pedicels stout. ....17. *P. riparia.*

t. Floral bracts not drying dark; pedicels slender.

u. Primary bracts about one-fifth as long as the branches; sepals acute, 30 mm. long. ..... 18. *P. alba.*

u. Primary bracts almost half as long as the branches; sepals obtuse and mucronulate, 35-40 mm. long. .... 15. *P. olivacea.*

s. Pedicels less than 15 mm. long; sepals narrow, acute or attenuate with a narrow blunt apex.

v. Lateral branches over 30 cm. long; floral bracts broadly elliptic. ..... 19. *P. Pearcei.*

v. Lateral branches not over 9 cm long; floral bracts ovate. ..... 20. *P. penduliflora.*

a. Branches of the inflorescence not more than twice as long as the primary bracts; inflorescence narrow.

w. Sepals glabrous or with a fine appressed deciduous stellate or lepidote indument.

x. Leaf-blades 12-30 mm. wide.

y. Branches spreading to slightly deflexed; inflorescence drying almost black. ..... 21. *P. atra.*
y. Branches erect or ascending.
z. Sepals 12 mm. long, ovate-elliptic. ..... 22. *P. dyckioides.*
z. Sepals 26-35 mm. long, narrow.
A. Floral bracts attenuate, lanceolate, slightly exceeding the pedicels. ..... 14. *P. glareosa.*
A. Floral bracts acute, elliptic, about equaling the sepals. ..... 23. *P. glabrescens.*
x. Leaf-blades 2-10 mm. wide, covered beneath with pale, narrow, spreading scales; lateral branches few-flowered.
B. Pedicels 4-7 mm. long, longer or shorter than the floral bracts; leaf-blades 2-3.5 mm. wide. ..... 24. *P. tuberosa.*
B. Pedicels 1 mm. long, the floral bracts 15 mm. long; leaf-blades 10 mm. wide. ..... 25. *P. reducta.*
w. Sepals densely lanate. ..... 26. *P. mollis.*

Subkey II

a. Sepals 12-60 mm. long; flowering shoot over 3 dm. high.
b. Inflorescence densely and coarsely ferruginous-stellate. ..... 16. *P. ferruginea.*
b. Inflorescence white-tomentellous to glabrous.
c. Floral bracts laciniate-spinose; sepals nearly 6 cm. long. ..... 27. *P. mirabilis.*
c. Floral bracts subspinulose to entire; sepals 25-40 mm. long.
d. Sepals 25 mm. long; floral bracts uniform, narrowly lanceolate. ..... 28. *P. Kuntzeana.*
d. Sepals 30-40 mm. long; lower floral bracts much larger and ampler than the others. ..... 11. *P. Meziana.*
a. Sepals 7-11 mm. long; flowering shoot slender, 9-30 cm. high.
e. Trichomes of the leaf-blade linear, spreading; flowering shoot 25-30 cm. high. ..... 24. *P. tuberosa.*
e. Trichomes of the leaf-blade broad, subspreading; flowering shoot 9 cm. high. ..... 29. *P. minima.*

Subkey III

a. Sepals glabrous or with fine appressed deciduous stellate or lepidote indument.
b. Lateral branches well developed, the flowers not fasciculate.
c. Floral bracts much exceeded by the sepals, ovate, inflated. ..... 13. *P. stenothyrsa.*
c. Floral bracts nearly equaling to exceeding the sepals.
d. Sepals 26 mm. long; floral bracts lustrous black. ..... 21. *P. atra.*
d. Sepals 17 mm. long; floral bracts dull, paler. ..... 10. *P. Fiebrigii.*

b. Lateral branches very short with the flowers fasciculate, but the inflorescence interrupted at base and obviously compound; sepals 11 mm. long. ..... 30. *P. paupera.*

a. Sepals densely lanate or tomentose, the indument mostly persistent after anthesis.

e. Floral bracts much exceeded by the sepals.

f. Leaf-blades densely appressed-lepidote beneath; floral bracts broadly ovate, ca. 35 mm. long. ..... 26. *P. mollis.*

f. Leaf-blades soon wholly glabrous; floral bracts elliptic-oblong, to 55 mm. long. ..... 31. *P. valida.*

e. Floral bracts exceeding the sepals.

g. Sepals 45 mm. long, narrowly lanceolate or linear; racemes secund. ..... 32. *P. lasiopoda.*

g. Sepals 20-30 mm. long; racemes not secund.

h. Branches ellipsoid, to 17 cm. long; pedicels 15 mm. long; sepals 30 mm. long. ..... 33. *P. Ugentiana.*

h. Branches globose, 6 cm. long; pedicels 7 mm. long; sepals 20 mm. long. ..... 34. *P. ctenorhyncha.*

Subkey IV

a. Outer bracts (the primary bracts or in a simple inflorescence the floral bracts) conspicuously serrate.

b. Apices of the thin outer bracts reflexed; inflorescence densely brown-lanate. ..... 35. *P. Fosteriana.*

b. Apices of the outer bracts erect; sepals soon glabrous and contrasting with the densely vestite pedicels. .... 23. *P. glabrescens.*

a. Outer bracts entire or very obscurely serrulate.

c. Apical part of each outer bract reflexed.

d. Inflorescence compound; flowers fasciculate.

e. Sepals 17-18 mm. long.

f. Inflorescence 8 cm. in diameter; outer bracts 7 cm. long. ..... 36. *P. tristis.*

f. Inflorescence 3 cm. in diameter; outer bracts 5 cm. long. ..... 37. *P. leptostachya.*

e. Sepals 25-30 mm. long.

g. Bracts all membranaceous and subhyaline, soon shattered; leaf-blades nearly glabrous. ..... 38. *P. Cardenasii.*

g. Bracts firmer, persistent; leaf-blades densely and conspicuously appressed-lepidote beneath. .... 39. *P. Herzogii.*

d. Inflorescence simple.

h. Floral bracts narrow, leaving much of the flower exposed (juvenile); sepals 25 mm. long. ..... 28. *P. Kuntzeana.*

h. Floral bracts ample; sepals 14 mm. long. .... 40. *P. tunarensis.*

c. Apical part of each outer bract erect.

i. Inflorescence compound with the flowers fasciculate.

j. Scape well developed; axis of the inflorescence elongate; sepals 11 mm. long. ..... 30. *P. paupera.*
j. Scape very short, completely hidden; inflorescence capitiform with all the axes aborted; sepals 35-40 mm. long. ..... 41. *P. nana.*
i. Inflorescence simple.
k. Sepals thinly vestite to glabrous.
l. Sepals 12-13 mm. long. ..... 42. *P. humilis.*
l. Sepals 25 mm. long. ..... 28. *P. Kuntzeana.*
k. Sepals densely lanate, 22 mm. long. ..... 43. *P. Brittoniana.*

Subgenus 2. PUYA

a. Caudex branching and continuing to live after the fruition and death of the flowering shoot; sepals 18 mm. long, exceeding the floral bracts. ..... 44. *P. Weddelliana.*
a. Caudex simple and columnar, dying after the fruition of the flowering shoot; sepals 40 mm. long, exceeded by the floral bracts. ..... 45. *P. Raimondii.*

1. **Puya ultima** L. B. Smith in Contrib. U. S. Nat. Herb. **29:** 540, *fig. 94* (1954). To 1.5 m. high. Leaf-blades 6 cm. wide, covered beneath with white, appressed scales, becoming wholly glabrous, the spines ascending, 10 mm. long, broad, black. Inflorescence bipinnate, ample, very lax, glabrous after anthesis. Primary bracts broadly ovate, acuminate, 5 cm. long, about equaling the sterile, naked bases of the branches, pectinate-serrate, subchartaceous. Branches spreading, slender, 5 dm. long, lax. Floral bracts ovate, acuminate, 2 cm. long, equaling or exceeding the slender pedicels, pectinate-serrate. Flowers ascending. Sepals narrowly triangular, strongly carinate, 40 mm. long. LA PAZ: SUR YUNGAS: La Paz to Irupana, 1500 m., *M. B. Foster* 2575 (US; type).

2. **P. alata** L. B. Smith in Phytologia, **7:** 422, t. 2, fig. 3, 4 (1961). *P. spathacea* of Catalogue Leaf-blades over 7 dm. long, 3 cm. wide, glabrous above, densely vestite beneath and on the margins with pale, subappressed scales, the spines lax, flat, antrorse, 10 mm. long. Inflorescence compound. Primary bracts elliptic, apiculate, 2 cm. long, shorter than the sterile base of the branch, entire, sparsely and minutely lepidote with linear white trichomes. Branches slightly flexuous, 3 dm. long, 3 mm. in diameter, very lax, angled, soon glabrous; floral bracts like the primary bracts, erect, much exceeding the pedicels. Pedicels slender, to 10 mm. long, sparsely pale-lepidote. Flowers pendent-secund. Sepals lanceolate, rounded and apiculate, 26 mm. long, even, soon glabrous, alate-carinate. POTOSÍ: LINARES: Lagunillas, 1000 m., *Cárdenas* 2851 (F; type).

3. **P. Hofstenii** Mez in Fedde, Rep. Nov. Spec. **3:** 8 (1906). *P. Hauthalii* Mez in Fedde, Rep. Spec. Nov. 16: 65 (1919). Over 1 m. high. Leaf-blades 5 dm. long, 5 cm. wide, densely cinereous-lepidote,

especially beneath, the spines antrorse, 5 mm. long. Inflorescence laxly bipinnate, 3-7 dm. long, glabrous. Primary bracts ovate, acute, about equaling the sterile bases of the branches, inflated, entire, stramineous. Branches spreading to suberect, to 20 cm. long, lax. Floral bracts ovate-elliptic, about equaling the slender, 15-18 mm. long pedicels. Flowers suberect to deflexed. Sepals lanceolate, rounded and apiculate, 26 mm. long. Petals 40 mm. long, naked or appendaged. POTOSÍ: NOR CHICHAS: Tala Chorolque near Guadalupe, *Hauthal* 101 (B; type of *Puya Hauthalii* Mez); Quechisla, 3500 m., *Cárdenas* 339. Argentina.

4. **P. potosina** L. B. Smith in Phytologia, **7**: 423, t. 2, fig. 7, 8 (1961). Leaf-blades over 5 dm. long, 25 mm. wide, densely vestite with pale, appressed scales but becoming glabrous above, the spines antrorse, 3 mm. long, brown. Scape 8 mm. in diameter at apex, glabrous. Scape-bracts small and exposing most of the upper scape, the ovate, serrulate base 2 cm. long, the slender, linear blade over 5 cm. long. Inflorescence laxly bipinnate, 7 dm. long, glabrous, somewhat glaucous. Primary bracts like the upper scape-bracts but with much shorter blades or merely apiculate, about equaling the sterile bases of the branches. Branches suberect, nearly straight, to 25 cm. long, 4 mm. wide at the flattened base, lax. Floral bracts ovate, apiculate, to 15 mm. long, entire, thin. Pedicels slender, enlarged upward, to 30 mm. long. Flowers more or less secund, often subverticillate. Sepals lanceolate, rounded and apiculate, 21 mm. long, carinate at base, sulcate when dry. Petals 4 cm. long, naked. POTOSÍ: NOR CHICHAS: Quechisla, 3400 m., *Cárdenas* 3738 (US; type).

5. **P. Trollii** L. B. Smith in Phytologia **16**: 461, t. 1, fig. 10, 11 (1968). Leaves over 7 dm. long; blades ca. 2 cm. wide, covered with pale appressed scales beneath, laxly serrate with dark antrorse spines 2 mm. long. Scape unknown. Inflorescence amply bipinnate, lax, soon glabrous, the fine white stellate trichomes uniform and completely deciduous. Primary bracts ovate, acuminate, much shorter than the sterile bases of the branches. Branches subspreading, to 26 cm. long, laxly flowered. Floral bracts broadly ovate, apiculate, mostly about half as long as the pedicels, thin, nerved, entire. Pedicels slender but strongly enlarged upward, to 20 mm. long. Flowers spreading. Sepals oblong, rounded, 15 mm. long, carinate toward base, sulcate when dry. Petals ca. 3 cm. long. POTOSÍ: Montecanto, *Troll* 661 (M; type).

6. **P. Rusbyi** (Baker) Mez in DC. Monog. Phan. **9**: 482 (1896). Flowering over 1 m. high. Leaf-blades over 35 cm. long, 25 mm. wide, covered with appressed white scales on both sides, becoming glabrous. Inflorescence amply bipinnate, covered with fine, white, stellate scales. Primary bracts many times shorter than the branches. Branches lax, 20-30 cm. long. Pedicels subspreading, slender, 20-25

mm. long, persistently vestite. Sepals lance-oblong, apiculate, 20-25 mm. long, more or less alate at base. Petals 4 cm. long, green and deep purple. Stamens exserted. LA PAZ: MURILLO: La Paz, 3000 m., *Rusby* 2846 (NY; type); *Balls* 5900 (F, US); San Jorge, 3600 m., *West* 6402 (UC).

7. **P. cristata** L. B. Smith in Lilloa, **14:** 95, fig. 7, 8 (1948). Flowering 1-1.5 m. high. Leaf-blades 7 dm. long, covered beneath with appressed, white scales, the spines antrorse, 12 mm. long, brown. Inflorescence compound, minutely white-flocculose. Primary bracts ovate, acuminate, about a third as long as the axillary branches, serrulate. Racemes lax, to 14 cm. long, the naked sterile base to 35 mm. long. Floral bracts acuminate from a broadly ovate base, exceeding the pedicels, subchartaceous when dry, very minutely serrulate. Flowers divergent, not secund. Pedicels slender, 10-15 mm. long, 3-angled at apex. Sepals ovate-lanceolate, acuminate, 25-32 mm. long, strongly crested at base, nerved when dry. Petals 4 cm. long, green. COCHABAMBA: AYOPAYA: Sailapata, 3000 m., *Cárdenas* 3311 (GH; type).

8. **P. laxa** L. B. Smith in Phytologia, **6:** 195, t. 1, fig. 7, 8 (1958). Flowering 8 dm. high. Leaf-blades 27 cm. long, caudate-acuminate with a long entire apex, densely tomentose with coarse white scales especially beneath, the spines antrorse, slender, 5 mm. long, brown. Scape 4 mm. in diameter, soon glabrous. Scape-bracts ovate, thin, the lower with small foliaceous blades, the upper merely acuminate, entire, much shorter than the internodes. Inflorescence laxly bipinnate, soon glabrous except for the white-puberulent pedicels. Primary bracts broadly ovate, apiculate, entire, to 25 mm. long, thin, mostly about half as long as the sterile bases of the branches. Branches spreading, straight, very slender, lax, the lateral to 23 cm. long. Floral bracts broadly ovate, apiculate, to 13 mm. long, slightly exceeding the slender pedicels, entire, membranaceous. Flowers not secund. Sepals lance-oblong, apiculate, 17 mm. long, thin, sulcate, slightly carinate at base. Petals 3 cm. long, violet. SANTA CRUZ: VALLE GRANDE: Pulquina, 1500 m., *Cárdenas* 5092 (US; type).

9. **P. sanctae-crucis** (Baker) L. B. Smith in Proc. Amer. Acad. **70:** 154 (1935). *Pitcairnia robusta* Rusby in Bull. N. Y. Bot. Gard. **6:** 488 (1910). Densely aggregated, flowering 1-2 m. high. Leaf-blades to 35 mm. wide, glabrous above, covered beneath with subspreading pale-cinereous scales, the spines mostly antrorse, 10 mm. long, broad, black. Scape stout, white-tomentose-lepidote, becoming glabrous. Scape-bracts erect, imbricate, subfoliaceous. Inflorescence amply bipinnate, lax, dark red except the petals, white-tomentose-lepidote, soon becoming glabrous. Primary bracts ovate, acuminate to apiculate, from about half as long as the naked sterile bases of the lower branches to slightly exceeding those of the upper ones, serrulate. Branches divergent, 14-30 cm. long, subdense. Floral bracts ovate,

apiculate, 15-22 mm. long, thin-coriaceous, often obscurely denticulate. Flowers suberect, more or less secund. Pedicels 5-10 mm. long, rather slender. Sepals lanceolate, acute, 20-28 mm. long, exceeding the floral bracts, sulcate when dry, the posterior ones obscurely carinate. Petals 4 cm. long, dark violet. BOLIVIA: *Castelnau* s. n. P; type); LA PAZ: MURILLO: Songo, *Bang* 892 (B, F, G, GH, M, MO, NY, US); CAUPOLICÁN: Apolo, *R. S. Williams* 2655 (NY; type of *Pitcairnia robusta* Rusby).

10. **P. Fiebrigii** Mez in Fedde, Rep. Spec. Nov. **3:** 9 (1906). Leaves unknown. Scape-bracts large, ovate, glabrous, serrate toward apex, the blades narrow, armed with stout, uncinate, castaneous, 4 mm. long spines, densely villous-lepidote beneath. Inflorescence bipinnate, glabrous. Lowest primary bracts like the scape-bracts, the others elliptic, entire, barely exceeding the short sterile bases of the branches. Branches to 23 cm. long, lax at base, dense toward apex. Floral bracts very broadly elliptic, 25 mm. long, nearly or quite equaling the sepals, inflated, entire. Flowers suberect. Pedicels to 15 mm. long, stout, thickened upward. Sepals ovate-elliptic, apiculate, 17 mm. long, subrigid. Petals 25 mm. long. Bolivia: *Fiebrig* 3210 (B; type); 3211.

11. **P. Meziana** Wittm. in Meded. Rijks Herbar. **29:** 85 (1916). *Pitcairnia grandiflora* of Catalogue. Flowering to 2.4 m. high. Leaves 45-85 cm. long, the blades 35 mm. wide, soon glabrous above, covered beneath with appressed, cinereous scales, the spines mostly antrorse, 10 mm. long. Inflorescence simple and pyramidal-cylindric or few-branched, finely white-tomentellous, all but the pedicels becoming glabrous, the axis stout. Floral bracts lanceolate, acuminate, pungent, the lowest 9 cm. long, ample, exceeding the sepals, subspinulose, submembranaceous, strongly nerved, the upper much reduced. Pedicels rather slender, to 15 mm. long. Sepals lanceolate, apiculate, 30-40 mm. long. LA PAZ: MURILLO: Miraflores to Obrajillo, 3600 m., *Buchtien* 8531 (US); La Paz, 3600 m., *Foster* 2560 (US); LOAIZA: Teneria, Quimzacruz Cordillera, 3000 m., *Herzog* 2487 (L; type).

12. **P. secunda** L. B. Smith in Phytologia **7:** 424, t. 2, fig. 11, 12 (1961). Flowering 1-2 m. high. Leaf-blades 35 mm. wide, glabrous above, covered beneath with coarse, subappressed, whitish scales, the spines antrorse, flat, 10 mm. long. Scape 2 cm. in diameter, densely and finely pale-floccose. Scape-bracts densely imbricate, the lower foliaceous, the upper acuminate from a broadly ovate base, serrulate, red. Inflorescence laxly bipinnate, at first finely white-floccose. Primary bracts like the upper scape-bracts, much shorter than the long sterile bases of the branches. Branches divergent, 15-30 cm. long, subdensely secund-flowered with the slender rhachis covered toward apex. Floral bracts ovate, acuminate, 20-25 mm. long, about equaling

the middle of the sepals, rather thin, red, obscurely serrulate, soon glabrous. Pedicels slender, 5-10 mm. long. Sepals linear-lanceolate, apiculate, 28 mm. long, ecarinate, soon glabrous. Petals dark violet. COCHABAMBA: Yungas, 3000 m., *M. B. Foster* 2550 (US); CHAPARE: Aguirre to Incachaca, 2000 m., *Cárdenas* 4381 (US; type).

13. **P. stenothyrsa** (Baker) Mez in DC. Monog. Phan. **9**: 481 (1896). *Pitcairnia Bangii* Baker in Mem. Torr. Bot. Club, **6**: 124 (1896). Plant to 1.5 m. high. Leaf-blades 40 mm. wide, densely white-lepidote beneath, the spines antrorse, nearly straight, 6 mm. long. Inflorescence amply bipinnate. Primary bracts very broadly ovate, laciniate-spinulose, the lower short-acuminate, the upper broadly acute. Branches to 20 cm. long, bearing 10-20 more or less secund flowers, tomentose-lepidote or glabrate. Floral bracts ovate, acute, 20 mm. long, exceeded by the sepals, entire or minutely serrulate, inflated, red, tomentellous toward base. Pedicels 10 mm. long, rather stout, ferruginous-tomentose. Sepals narrowly elliptic-triangular, rounded and mucronulate, 33 mm. long, 9 mm. wide, sparsely lepidote. Petals 5 cm. long, violet. LA PAZ: LARECAJA: Sorata, 2650-3300 m., *Mandon* 1189 (K; type); *Bang* 1631 (BM; type of *Pitcairnia Bangii* Baker; GH, NY, US); 2700 m., *Cárdenas* 1217 (GH). COCHABAMBA: TOTORA: Incallacta to Totora, 3800 m., *Cárdenas* 2373 (GH); CAPINOTA: Panduro, Río Caine, *Cárdenas* 3444 (GH); CERCADO: Taquina, 12 km. north of Cochabamba, 2700 m., *Cárdenas & Cutler* 7408 (GH).

14. **P. glareosa** L. B. Smith in Lilloa, **14**: 96 (1948). Plant to 1 m. high. Leaf-blades 5 cm. wide, densely white-lepidote beneath, the spines antrorse, curved, brown. Inflorescence bipinnate, minutely white-flocculose. Primary bracts oblong-ovate, acuminate, to 7 cm. long, a half to a third as long as the axillary branches, subchartaceous when dry, minutely serrulate. Racemes subsessile, suberect to divergent, the rhachis 14-15 cm. long, sulcate. Floral bracts lanceolate, acuminate, slightly exceeding the pedicels, minutely erose, membranaceous. Flowers divergent. Pedicels slender, to 17 mm. long. Sepals narrowly lanceolate, acuminate, 26 mm. long, slightly carinate at base, subcoriaceous. Petals 4 cm. long. LA PAZ: PACAJES: Calacoto, 3600 m., *Cárdenas* 3583 (GH; type).

15. **P. olivacea** Wittm. in Meded. Rijks Herbar. **29**: 83 (1916). To 1.5 m. high. Leaf-blades 3-4 cm. wide, pale-lepidote, becoming glabrous, the spines 5 mm. long, dark, slender. Scape elongate, glabrous. Scape-bracts broadly ovate, soon disintegrating. Inflorescence amply paniculate, lax, olivaceous-glaucous, covered with fine white stellate trichomes when young. Primary bracts suborbicular, apiculate, 4 cm. long, exceeding the short, sterile, naked bases of the branches, serrate, subchartaceous, soon disintegrating. Branches divergent, simple, laxly few-flowered, 10-12 cm. long. Floral bracts elliptic, apiculate, 3 cm. long, equaling or exceeding the slender pedicels, serrulate. Sepals

lanceolate, obtuse and mucronulate, 35-40 mm. long, thickened at base but not carinate. Petals 6-7 cm. long, pale lilac. SANTA CRUZ: CORDILLERA: Quebrada de Charagua, 950 m., *Herzog* 1216 (L; type); Lagunillas, 1050 m., *Cárdenas* 4786 (US); VALLE GRANDE: Valle Grande, 2000 m., *Cárdenas* 5300 (US).

16. **P. ferruginea** (R. & P.) L. B. Smith, Phytologia **16:** 461 (1968). *Pitcairnia ferruginea* R. & P. Fl. Peruv. **3:** 36 (1802). *Pitcairnia consimilis* Baker in Journ. Bot. **19:** 266 (1881). Very variable, flowering to nearly 4 m. high. Stem stout, woody, covered with the remains of dead leaves. Leaf-blades narrowly triangular, attenuate, 5 cm. wide, coarsely spinose-serrate, white-lepidote beneath. Scape stout, rather woody, ferruginous-stellate, then glabrous. Scape-bracts ovate, attenuate, at least the lowest serrate. Inflorescence usually paniculate, laxly pyramidal, covered with ferruginous stellate scales. Primary bracts like the upper scape-bracts, much shorter than the branches and usually not equaling their sterile bases. Branches secundly many-flowered. Floral bracts ovate, acute, entire, usually shorter than the pedicels. Pedicels slender, 1-6 cm. long. Sepals oblong, obtuse, 12-45 mm. long, densely ferruginous-stellate. Petals to 14 cm. long though often much smaller, greenish to various shades of purple, usually with 2 vertical calli near base but varying to completely naked in a single flower. Stamens included. Ovary 2/3 superior. Ovules narrowly winged. Capsule globose, 25 mm. long. LA PAZ: MURILLO: La Paz, 3600 m., *Balls* 5881 (US); 3000 m., *Bang* 152 (BM, GH, US); 3800 m., *Buchtien* s. n. (BM, GH); 810 (US); 3600 m., *Foster* 2561 (US); *Rose* 18854 (US); 3000 m., *Rusby* 2845 (NY); 3450 m., *Williams* 2355 (NY); Cerros de Obrajes, 3600 m., *Cárdenas* 2403 (GH); La Paz to Hacienda Chaco, 1200 m., *Foster* 2577 (US); LARECAJA: Sorata, 2650-3700 m., *Mandon* 1173 (BM, GH, K, S; type no. of *Pitcairnia consimilis* Baker); YUNGAS: 1800 m., *Rusby* 2847 (F, NY, US); Cordillera Real, Nequejahuira, 2400 m., *Tate* 634 (NY). WITHOUT LOCALITY: *Kuntze* s. n. (NY). Ecuador, Peru.

17. **P. riparia** L. B. Smith in Phytologia, **7:** 424, t. 2, fig. 9, 10 (1961). Flowering about 1.5 m. high. Leaf-blades 2 cm. wide, glabrous above, covered beneath with cinereous scales, the spines lax, slender, pale, uncinate, mostly antrorse, 4-5 mm. long. Scape 2 cm. in diameter, soon glabrous except the nodes. Scape-bracts deciduous, unknown. Inflorescence laxly bipinnate, narrowly pyramidal, 7 dm. long, drying black, densely white-lanate. Primary bracts ovate, acute, ample, much exceeding the short, flat, sterile bases of the branches, thin-coriaceous, becoming glabrous, the margins crisped when dry. Lateral branches few, basal, 10-15 cm. long, lax, their floral bracts shorter than the sepals, the terminal branch elongate with floral bracts the size of the primary bracts and much exceeding the sepals. Pedicels rather stout, 20 mm. long. Flowers more or less

secund. Sepals lance-elliptic, apiculate, 42 mm. long, dull and rather rugose on drying. Petals over 6 cm. long. LA PAZ: MURILLO [?]: Road to Hacienda Chaco, eastern Cordillera, *M. B. Foster* 2578 (US; type).

18. **P. alba** L. B. Smith in Phytologia, 5: 49, t. 7, fig. 3-5 (1954). Plant 2 m. high. Leaves unknown. Inflorescence laxly bipinnate, persistently white-flocculose. Primary bracts suborbicular, apiculate, 3 cm. long, densely serrate. Branches divergent, 15 cm. long, subdense with pendent-secund flowers. Floral bracts elliptic, acute, about equaling the pedicels, entire, subcoriaceous. Pedicels slender, to 25 mm. long. Sepals narrowly lanceolate, acute, 30 mm. long, ecarinate. Petals over 5 cm. long, white, bearing 2 long vertical calli near the base. TARIJA: O'CONNOR: Palos Blancos, 800 m., *Cárdenas* 4952-a (US; type).

19. **P. Pearcei** (Baker) Mez in DC. Monog. Phan. 9: 480 (1896). Over 1 m. high. Leaf-blades 40 mm. wide, glabrous or sparsely lepidote throughout, the spines antrorse, 10 mm. long. Inflorescence amply bipinnate. Primary bracts narrowly triangular, densely spinulose-serrate, much shorter than the sterile naked bases of the branches. Branches ascending from a suberect to spreading base, over 3 dm. long, flavous-tomentose especially toward apex. Floral bracts broadly elliptic, apiculate, 20 mm. long, entire, membranaceous, glabrous or puberulent. Flowers spreading, more or less secund. Pedicels to 10 mm. long, rather slender, densely short-tomentose. Sepals narrowly lanceolate, apiculate, 32 mm. long, much exceeding the floral bracts, finely appressed-tomentose. Without locality: *Bang* s.n. (GH, NY, type); Milluguaya, 1300 m., *Buchtien* 4287 (US); LARECAJA: Tipuani, US). LA PAZ: NOR YUNGAS: Coroico, 900-1200 m., *Pearce* s. n. (K; 1400 m., *Buchtien* 7179 (US). COCHABAMBA: Puente Villa, 1400 m., *Cárdenas* 3689 (GH, US); Pasorapa, *Cárdenas* 5924 (US).

20. **P. penduliflora** L. B. Smith in Contrib. Gray Herb. 98: 12, t. 4, fig. 3, 4 (1932). Flowering 6 dm. or higher. Leaf-blades (on the basis of the lower scape-bracts) glabrous above, sparsely and minutely lepidote beneath, the spines antrorse, castaneous. Scape rather slender, soon glabrous. Scape-bracts ovate, serrulate, submembranaceous, red, the lower with a long blade. Inflorescence few-branched, 25 cm. long, very finely white-tomentose. Primary bracts ovate, acute, much shorter than the branches, serrulate, submembranaceous, red, nerved. Branches laxly few-flowered, briefly sterile at apex, complanate at base, the lateral not over 9 cm. long. Floral bracts like the primary but entire, slightly exceeding the pedicels. Flowers pendulous. Pedicels to 13 mm. long. Sepals narrowly lanceolate, acuminate, 35 mm. long. Petals 45 mm. long, greenish violet when dry. LA PAZ: LARECAJA: Tipuani, 1400 m., *Buchtien* 7182 (US; type).

21. **P. atra** L. B. Smith in Contrib. U. S. Nat. Herb. **29:** 536, fig. 90 (1954). Caulescent with a caudex like that of *Yucca aloifolia*, the flowering shoot over 2 m. high. Leaf-blades 25 mm. wide, soon glabrous, the spines mostly antrorse, 5 mm. long, dark. Scape 2 cm. in diameter, tomentose-lepidote, soon glabrous. Scape-bracts densely imbricate, subfoliaceous, the blades subdensely lepidote above with fine, irregular, white scales. Inflorescence densely but distinctly bipinnate, covered with fine, stellate, ferruginous scales, soon glabrous. Primary bracts broadly ovate, acute, 8 cm. long, even or faintly striate, black, lustrous. Branches spreading to slightly deflexed, ellipsoid, 9-10 cm. long exclusive of the short stout sterile base, 5-6 cm. in diameter. Floral bracts imbricate, very broadly elliptic, obtuse, 4 cm. long, exceeding the sepals, sparsely and very minutely serrulate, subchartaceous, black, lustrous. Pedicels slenderly cylindric, 8 mm. long. Sepals narrowly elliptic, obtuse, 26 mm. long, carinate, lustrous. COCHABAMBA: Above Yungas, 3150 m., *Foster* 2551 (US; type); CARRASCO: Jatum Pino, 3000 m., *Cárdenas* 5285 (US).

22. **P. dyckioides** (Baker) Mez in DC. Monog. Phan. **9:** 486 (1896). Stemless, 4-7 dm. high. Leaf-blades 12-20 mm. wide, glabrous above, covered beneath with pale, appressed scales. The spines antrorse, 3 mm. long, curved. Scape 15 mm. in diameter, furfuraceous at first. Scape-bracts imbricate, broadly ovate, acuminate to a linear blade, densely serrulate. Inflorescence bipinnate, subdensely cylindric, 2-4 dm. long, 5-8 cm. in diameter, the axes furfuraceous when young. Primary bracts like the scape-bracts but more coarsely serrate and the upper bladeless, 45-60 mm. long. Branches erect or divergent, slightly if at all exceeding the primary bracts, subdensely few-flowered. Floral bracts ovate-elliptic, apiculate, nearly or quite equaling the sepals, entire or serrulate, thin, nerved. Pedicels 5-7 mm. long, slender. Sepals ovate-elliptic, 12 mm. long, glabrous, nerved. Petals 20 mm. long, green. CHUQUISACA: TOMINA: *Weddell* 3739 (P; type); Tomabamba, *Weddell* 3881 (P). TARIJA: CERCADO: Tarija, *West* 8323 (UC). Argentina.

23. **P. glabrescens** L. B. Smith in Contrib. U. S. Nat. Herb. **29:** 537, fig. 91 (1954). Flowering 6-8 dm. high. Leaf-blades 2-3 cm. wide, at first covered on both sides with gray appressed scales, the spines slender, curved, 10 mm. long. Scape erect, shorter than the leaves, stout. Inflorescence bipinnate, densely cylindric, densely and finely white-lanate with the bracts and sepals soon becoming glabrous. Primary bracts persistent, elliptic, ample, acute, to 13 cm. long, equaling the branches, opaque, serrate. Floral bracts elliptic, acute, about equaling the sepals, serrulate. Pedicels slender, 16 mm. long. Sepals lance-ovate, acuminate, much thickened centrally but not winged, 35 mm. long, coriaceous. Petals 55 mm. long. COCHABAMBA: TARATA: Llallaguani to Anzaldo, 3000 m., *Cárdenas* 4383 (US); 4384

(US; type); CERCADO: Taquina, 10 km. east of Cochabamba, 2900 m., *Eyerdam* 25311 (UC, US); Tunari, 2850 m., *Foster* 2538 (US); 2539 (US); AYOPAYA: Parangani, 2560 m., *Cárdenas* 4811 (US).

24. **P. tuberosa** Mez in DC. Monog. Phan. **9:** 483 (1896). Flowering plant less than 3 dm. high including the very short erect rhizome. Leaf-sheaths forming a globose bulb 3 cm. in diameter, the blades linear, flexuous, filiform-acuminate, 15-18 cm. long, 2-3.5 mm. wide, glabrous above, covered with pale, narrow, spreading scales beneath, the spines spreading or ascending, fine, 1-2 mm. long. Scape slender, white-flocculose, becoming glabrous. Scape-bracts ovate with long, filiform blades, pale-lepidote. Inflorescence simple or with a few short branches at base, cylindric, 7-10 cm. long, white-flocculose at first. Primary bracts ovate, acuminate, 2 cm. long, longer or shorter than the laxly few-flowered branches, minutely serrulate. Floral bracts ovate, acute, thin, red. Pedicels slender, 4-7 mm. long, longer or shorter than the floral bracts. Sepals lance-oblong, acute, 7-9 mm. long. Petals 14 mm. long, blue-violet. Bolivia: "Peru", *Haenke* (M; type); SANTA CRUZ: VALLE GRANDE: Cuesta de Los Monos, 1000 m., *Cárdenas* 4647 (US); El Fuerte to Samaipata, 1800 m., *Cárdenas* 5198 (US).

Note: Haenke was near the two Cárdenas localities and most species of *Puya* have very restricted ranges, so his material probably came from this same general area.

25. **P. reducta** L. B. Smith in Phytologia, **10:** 472, t. 1, fig. 1, 2 (1964). Leaf-blades ca. 4 dm. long, glabrous above, subdensely tomentose beneath with white linear trichomes, the spines slender, pale, antrorse, 4 mm. long. Scape erect, ca. 3 mm. in diameter, finely white-stellate. Scape-bracts erect, ovate with a caudate apex, red, the upper ones about equaling the internodes. Inflorescence laxly bipinnate, sparsely white-stellate, becoming glabrous. Primary bracts like the upper scape-bracts but not caudate, nearly the same size and form as the floral bracts, exceeding the axis of the very short few-flowered lateral branches. Branches divergent to spreading with a very short naked sterile base, subdense but with the axis largely exposed. Floral bracts suberect, broadly ovate, acute and apiculate, 15 mm. long, ecarinate, broadly convex, red with a narrow scarious margin, subchartaceous. Pedicels about 1 mm. long but slender and distinct. Sepals linear-lanceolate, narrowly obtuse and apiculate, 27 mm. long. Petals ca. 4 cm. long, naked. LA PAZ: CAUPOLICÁN: Altunkama, 2600 m., *Cárdenas* 5687 (US; type).

26. **P. mollis** Baker ex Mez in DC. Monog. Phan. **9:** 488 (1896). Leaf-blades 4 cm. wide, glabrous above, covered beneath with fine, appressed, cinereous scales, the spines antrorse, uncinate, pale brown, 5 mm. long. Scape unknown. Inflorescence compound, dense, stout-cylindric or ellipsoid, densely white-lanate. Primary bracts ovate,

acuminate, some nearly equaling the branches, others about half as long, thick, coriaceous, slightly serrulate toward apex. Branches suberect, to 10 cm. long with a tuft of sterile bracts at apex. Floral bracts straight, broadly ovate, acute, 35 mm. long, much exceeded by the sepals, entire, thick, coriaceous. Pedicels stout, 15 mm. long. Sepals subacute, 28 mm. long, very thick. Petals 6 cm. long, greenish violet. Stamens included. LA PAZ: LARECAJA: Sorata, 2700-3000 m., *Mandon* 1190 (BR, GH, P); *Bang* 1629 (K; type; BM, GH, US).

27. **P. mirabilis** (Mez) L. B. Smith in Phytologia **16:** 461 (1968). *Pitcairnia mirabilis* Mez in Fedde, Repert. Spec. Nov. **3:** 6 (1906). Flowering to 1.5 m. high. Leaves persistent, the sheaths broadly ovate, very thick, forming an epigaeous bulb, the blades linear, attenuate, not contracted at base, 10-15 mm. wide, coarsely spinose-serrate, soon glabrous. Scape stout, glabrous. Scape-bracts erect, exceeding the internodes but exposing the scape, broadly ovate, the lower with long spinose blades, the upper with short ones. Inflorescence laxly racemose, cylindric, 3 dm. long, the axis stout, straight. Floral bracts suberect to spreading, broadly ovate-elliptic, attenuate, 30 mm. long, exceeding the pedicels, laciniate-spinose. Pedicels suberect at anthesis, becoming decurved, 12 mm. long. Sepals subtriangular, slightly asymmetric and obscurely mucronulate at apex, nearly 6 cm. long, ecarinate, thick, coriaceous. Petals 95 mm. long, yellow-green, naked. Stamens included. Ovary 3/4 superior. Ovules alate. COCHABAMBA: CERCADO: Cerro San Pedro, Cochabamba, 2560 m., *Cárdenas* 3835 (GH); *Adolfo* 177 (US); QUILLACOLLO: Cerro del Calvario, 2560 m., *Cárdenas* 3578 (GH). TARIJA: ARCE: Bermejo, 1400 m., *Fiebrig* 2320 (B; type); O'CONNOR: Chuquiaca, *Fiebrig* 2420a (B). Argentina.

28. **P. Kuntzeana** Mez in DC. Monog. Phan. **9:** 490 (1896). Flowering over 1 m. high. Leaves unknown. Scape stout, densely white-tomentose when young, becoming glabrous. Scape-bracts (upper) reflexed, lance-triangular, ca. 15 cm. long, sparsely laciniate-spinulose. Inflorescence simple, densely cylindric, subacute, 30 cm. long, ca. 7 cm. in diameter, densely tomentulose when young, becoming glabrous. Floral bracts narrowly lanceolate, equaling or exceeding the sepals, entire, submembranaceous, the lowest reflexed, the others erect or suberect. Flowers erect or suberect. Pedicels slender, to 12 mm. long. Sepals subelliptic, triangular-acute, 25 mm. long, 8 mm. wide. Petals obtuse, 46 mm. long, brownish. Stamens exserted. COCHABAMBA: CERCADO: Tunari, 1300 m., *Kuntze* s. n. (NY; type).

29. **P. minima** L. B. Smith in Phytologia **7:** 423, t. 2, fig. 5, 6 (1961). Flowering only 10 cm. high. Leaves forming a subbulbous rosette, to 12 cm. long, the blades 6 mm. wide, covered on both sides with suborbicular, slightly spreading, cinereous scales, becoming glabrous above, the spines retrorse, 1.5 mm. long, yellow-brown. Scape slender, stellate-lepidote, mostly hidden by the leaves. Scape-bracts imbricate,

the upper ovate, acute, thin. Inflorescence simple, 4 cm. long, subdense, few-flowered, sparsely stellate-lepidote. Floral bracts like the upper scape-bracts, to 13 mm. long, much exceeding the pedicels, bright red. Pedicels slender, 8 mm. long. Sepals oblong, broadly acute and apiculate, 11 mm. long. Petals 15 mm. long. TARIJA: MENDEZ: Sama, 2500 m., *West* 8345 (UC; type).

30. **P. paupera** Mez in Fedde, Repert. Spec. Nov. **3:** 14 (1906). Stemless, flowering 22 cm. high. Leaf-blades 7 mm. wide, velutinous-lepidote especially beneath, the spines dense, slender, 3 mm. long. Scape slightly exceeding the leaves, densely velutinous. Scape-bracts erect, exceeding the internodes, sublanceolate, bladeless, subglabrous, minutely spinose. Inflorescence subsimple, rather densely cylindric, slightly or not interrupted at base, 10 cm. long, 15 mm. in diameter. Branches basal with one normal and one abortive flower, shorter than the bracts. Floral bracts ovate, acuminate, 20 mm. long, denticulate, glabrous, nerved. Flowers erect. Pedicels 6 mm. long. Sepals oblong, obtuse, 11 mm. long, minutely araneose. Petals 15 mm. long, blue or violet. TARIJA: CERCADO: Tucumilla, 2600 m., *Fiebrig* 2005 (B; type).

31. **P. valida** L. B. Smith in Phytologia, **10:** 474, t. 1, fig. 3, 4 (1964). Flowering 3 m. high. Leaf-blades 4 cm. wide, soon wholly glabrous, laxly serrate with brown stiffly antrorse brown spines 3 mm. long. Scape erect, over 4 cm. in diameter (! photo). Scape-bracts early deciduous, unknown. Inflorescence subdensely bipinnate, over 1 m. long, except for the petals and genitalia covered with a fine white dense appressed tomentum. Primary bracts small and inconspicuous (! photo). Branches subspreading, strobilate, nearly 3 dm. long, 7 cm. in diameter. Floral bracts elliptic-oblong, acute and apiculate, to 55 mm. long, distinctly exceeded by the sepals, coriaceous, rigid, very minutely serrate toward apex. Flowers suberect. Pedicels subcylindric, 2 cm. long, 5 mm. in diameter. Sepals lance-elliptic, rounded and apiculate, 35 mm. long, coriaceous when dry, ecarinate. Petals naked, twisted together after anthesis. CHUQUISACA: CAMPERO: Río Chico, 2500 m., *Cárdenas* 6012 (US; type).

32. **P. lasiopoda** L. B. Smith in Proc. Amer. Acad. **70:** 153 (1935). Leaves and scape unknown. Inflorescence laxly bipinnate, tomentose-lepidote. Primary bracts ovate, exceeding the long, slender, sterile bases of the branches, minutely serrate, submembranaceous, red. Racemes secund, dense, ellipsoid, 10 cm. long, 5 cm. in diameter. Floral bracts like the primary bracts but smaller and entire, about equaling the sepals. Flowers erect. Pedicels slenderly obconic, 7 mm. long. Sepals narrowly lanceolate, uncinate at apex, 45 mm. long, ecarinate. Petals acute, 6 cm. long, dark violet. Stamens about equaling the petals or slightly exserted. BENI: YACUMA: Reyes, 500 m., *Rusby* 2232 (NY; type). PUNO: CARABAYA: Ollachea to Quillabamba, *Vargas* 17515 (US).

33. **P. Ugentiana** L. B. Smith in Phytologia, **13:** 147, t. 7, fig. 1, 2 (1966). Leaf-blades 6 cm. wide, obscurely lepidote between the nerves beneath, covered with appressed cinereous scales above, the spines antrorse, 3 mm. long. Scape 5 cm. in diameter, soon glabrous. Scape-bracts persistent, exceeding the internodes, the upper broadly triangular with short serrate blades, partly exposing the scape. Inflorescence lax, bipinnate, over 1 m. long, finely and densely whitish-stellate including the petals. Primary bracts much shorter than the axillary branches. Spikes subspreading, strobilate, subsessile, the central ones to 17 cm. long. Floral bracts lanceolate, acute, nearly 5 cm. long and about equaling the sepals. Pedicels slenderly subcylindric, 15 mm. long. Sepals lanceolate, narrowly obtuse, 30 mm. long. Petals linear. Capsules subglobose, 2 cm. long. CHUQUISACA: OROPEZA: Sucre to Aiqule, 1950 m., *Ugent* 4998 (US; type; WIS).

34. **P. ctenorhyncha** L. B. Smith in Phytologia, **5:** 49, t. 7, fig. 6-9 (1954). Plant 1.2 m. high. Leaf-blades 35 mm. wide, glabrous above, covered beneath with appressed, gray scales, the spines lax, red-brown, 4 mm. long. Scape stout, white-lanate. Scape-bracts erect and exceeding the internodes but not wholly covering the scape, broadly ovate with small, subfoliaceous blades, very dark brown, subcoriaceous, persistent, serrate, floccose. Inflorescence densely bipinnate, fusiform, 3 dm. long, 8 cm. in diameter, densely white-lanate. Primary bracts like the scape-bracts but their narrowly triangular apices notably pectinate and not at all foliaceous, 6 cm. long, equaling or exceeding the globose, few-flowered spikes. Floral bracts elliptic, apiculate, 35 mm. long, exceeding the sepals. Pedicels rather slender, 7 mm. long. Sepals elliptic, broadly acute, 20 mm. long, coriaceous. Petals 4 cm. long, light yellow-green. LA PAZ: LARECAJA: Anilaya to Larecaja, 3500 m., *Cárdenas* 4867 (US; type).

35. **P. Fosteriana** L. B. Smith in Journ. Wash. Acad. Sci. **40:** 216, fig. 1 (1950). Plant 1 m. high. Leaf-blades 5 cm. wide, glabrous above, minutely pale-lepidote between the nerves beneath, the spines dark, flat, straight or uncinate, 9 mm. long. Scape very short, concealed by the leaves. Inflorescence very densely bipinnate, thick-cylindric, rounded at apex, densely brown-lanate. Primary bracts membranaceous, pale green, the suborbicular base equaling the sepals, the long, narrowly triangular apex reflexed, coarsely serrate. Branches much abbreviated, few-flowered. Floral bracts broadly elliptic, long-caudate, exceeding the sepals, subentire, membranaceous, lightly green, drying stramineous. Pedicels rather slender, 1 cm. long. Sepals linear-lanceolate, acute, 45 mm. long, ecarinate, minutely and sparsely serrate, submembranaceous. Petals broadly elliptic, ultramarine, dark purple at base. LA PAZ: MURILLO: La Rinconada, about 75 km. east of La Paz, 4400 m., *M. B. Foster* 2573 (US; type).

36. **P. tristis** L. B. Smith in Phytologia, **10:** 475, t. 1, fig. 5-7 (1964).

Flowering 6 dm. high. Leaf-blades 15 mm. wide, glabrous above, covered beneath with appressed white scales, laxly serrate with dark uncinate spines 4 mm. long. Scape exceeding the leaves, coarsely brown-tomentose. Scape-bracts subfoliaceous, strict, densely imbricate, brown-tomentose toward base. Inflorescence densely ovoid, broadly rounded, 10 cm. long, 8 cm. in diameter, obscurely bipinnate, densely and coarsely brown-tomentose except the petals. Primary bracts attenuate from a suborbicular base, to 7 cm. long, membranaceous, finely nerved, entire, the apical half reflexed at anthesis. Branches nearly aborted, 2-flowered. Floral bracts like the primary bracts but short-attenuate and only 35 mm. long. Pedicels short but slender and distinct. Sepals oblong-elliptic, rounded and apiculate, 18 mm. long, thin. Petals over 3 cm. long, blue. COCHABAMBA: CHAPARE: km. 89, Cochabamba to Chapare, 3900 m., *Cárdenas* 6067 (US; type).

37. **P. leptostachya** L. B. Smith in Lilloa, **14:** 97, fig. 11, 12 (1948). Flowering 4-5 dm. high. Leaf-blades 12 mm. wide, glabrous above, covered beneath with subappressed, cinereous, black-centered scales, the spines lax, dark, uncinate, 4 mm. long. Scape short. Scape-bracts very densely imbricate, shortly foliaceous-laminate from a broadly elliptic, subchartaceous, lepidote sheath. Inflorescence slenderly cylindric, depauperate-paniculate, 3 cm. in diameter. Primary bracts acuminate from a broadly ovate base, 5 cm. long, entire, membranaceous, sparsely brown-lanate at base, strongly reflexed above the middle. Branches nearly aborted, 2-flowered, wholly hidden. Floral bracts elliptic, acuminate, 25-30 mm. long, much exceeding the sepals, entire, membranaceous, brown-lanate. Pedicels slenderly obconic, 4 mm. long. Sepals elliptic, broadly acute or obtuse, 17 mm. long, thin, ecarinate, strongly nerved, lanate. Petals 3 cm. long, blue. COCHABAMBA: CHAPARE: Cuesta de Llanta, Aduana near Colomi, 3400 m., *Cárdenas* 3581 (GH, type). Peru.

38. **P. Cardenasii** L. B. Smith in Lilloa, **14:** 94, fig. 6 (1948). Plant 1.5 m. high. Leaf-blades 3 cm. wide, nearly glabrous, the spines very lax, brown, straight or curved, 8 mm. long. Scape very short, hidden by the leaves. Inflorescence densely cylindric, appearing simple but actually bipinnate, 25 cm. long, 12 cm. in diameter, pale-lanate, glabrous in fruit. Primary bracts ample, about equaling the branches, obscurely serrulate, membranaceous, reflexed, fragile. Branches densely few-flowered. Floral bracts like the primary bracts, exceeding the sepals. Pedicels slenderly obconic, 10 mm. long. Sepals broadly lanceolate, acute, 25 mm. long, ecarinate, thin-coriaceous. Petals 4 cm. long, blue. COCHABAMBA: CERCADO: Tunari, 3800 m., *Cárdenas* 4082 (US; type); 3900 m., *M. B. Foster* 2540 (US).

39. **P. Herzogii** Wittm. in Meded. Rijks Herbar. **29:** 86 (1916). Flowering 2 m. high. Leaf-blades 2 cm. wide, glabrous above, densely cinereous-lepidote beneath, minutely spinose-serrate. Scape erect or

slightly curved, elongate, stout, much exceeding the leaves. Scape-bracts refracted, soon deciduous. Inflorescence densely cylindric or ellipsoid, compound, 2-3 dm. long, covered with a yellowish-white wool. Primary bracts large, broadly ovate or obovate with a deltoid apiculus, fuscous when dry, suberose, slightly exceeding the few-flowered spikes, recurved toward apex; floral bracts like the scape-bracts, equaling or slightly exceeding the sepals. Pedicels 10 mm. long. Sepals ovate-oblong, subacute, 30 mm. long, covered on both sides with a dense easily detached wool. Petals 5 cm. long, flavous. Stamens included. COCHABAMBA: CHAPARE: Incacorral, *Herzog* 2269 (L; type); Colomi, 3300 m., *Cárdenas* 2251 (GH); AYOPAYA: Sailapata, 3700 m., *Cárdenas* 3306 (US); CERCADO: Tunari, *Kuntze* s. n. (NY); 3600 m., *M. B. Foster* 2541 (US); *Cárdenas* 6276 (US); TOTORA: Incallajta to Carrasco, *Cárdenas* 6275 (US).

40. **P. tunarensis** Mez in DC. Monog. Phan. **9**: 498 (1896). Flowering 4-7 dm. high. Leaf-blades 3 dm. long, 15 mm. wide, woody, very stiff, densely cinereous-lepidote beneath, the spines dense, subspreading, 5 mm. long. Scape short, stout. Scape-bracts erect, imbricate, broadly ovate, acuminate. Inflorescence simple, densely cylindric, 20 cm. long, 3 cm. in diameter, many-flowered. Floral bracts elliptic or ovate-elliptic, apiculate, 20 mm. long, about equaling the petals but decurved at apex, entire, scarious, pulverulent-lepidote, flavous. Pedicels very short. Sepals ovate-elliptic, acuminate, 14 mm. long, carinate, coriaceous, flavous, subglabrous or sparsely lepidote. Petals 17 mm. long, dull red-brown. Stamens exserted. COCHABAMBA: CERCADO: Tunari, 1400 m., *Kuntze* s. n. (NY; type); Toralapa to Cochabamba 3700 m., *Cárdenas* 3580 (US); TOTORA: Quirusillani, 3800 m., *Cárdenas* 2372 (GH); TARATA: Anzaldo, 3600 m., *Cárdenas, Cutler & Gandarillas* 7639 (US); Cocha to Vilavila, 2850 m., *M. B. Foster* 2555 (US).

41. **P. nana** Wittm. in Mededeel. Rijks Herb. **29**: 85. (1916). *Pitcairnia nana* (Wittm.) L. B. Smith in Contrib. Gray Herb. 89: 7 (1930). Leaves many in a spreading rosette, the blades linear-triangular, over 6 dm. long, 25 mm. wide, glabrous above, densely cinereous-lepidote beneath, laxly serrate with dark antrorse spines 5 mm. long; scape very short and hidden; inflorescence semiglobose, dense, 15 cm. in diameter. Outer bracts ovate or ovate-oblong with a narrowly deltoid apex, entire, 45-50 mm. long, 15-20 mm. wide, subcoriaceous, lustrous, roseate, drying to yellow-brown with a very dark base, subfurfuraceous to glabrous. Floral bracts like the outer bracts but narrower and more furfuraceous, about equaling the sepals. Pedicels broadly obconic, 15 mm. long, compressed. Sepals narrowly lanceolate, attenuate to a pungent apex, 35-40 mm. long, 10 mm. wide, carinate. Petals subacute, slightly exceeding the sepals, naked, blue-green. Stamens barely exserted. Ovary ¼ inferior. Ovules winged.

SANTA CRUZ: VALLE GRANDE: Samaipata, 2100 m., *Herzog* 1856-a (L; type); same, alt. 1800 m., *Cárdenas* 5533 (US).

42. **P. humilis** Mez in DC. Monog. Phan. **9:** 498 (1896). *P. Werdermannii* Harms of Catalogue. Cespitose with a rhizome 15 cm. in diameter, the flowering shoot 15-25 cm. high. Leaf-blades 7 mm. wide, cinereous-lepidote especially beneath, the spines lax, spreading, 3 mm. Scape very short, white-tomentellous, becoming glabrous. Scape-bracts densely imbricate, broadly ovate-elliptic with foliaceous blades. Inflorescense simple, strobilate, fusiform, 6-8 cm. long, 25 mm. in diameter, few-flowered, the axis densely white-tomentose. Floral bracts strict, broadly ovate, acuminate, 20-28 mm. long, exceeding the petals, entire, pungent, appressed-lepidote, becoming glabrous, nerved. Pedicels 2-3 mm. long. Sepals subtriangular, acutish, 12-13 mm. long, carinate, sparsely lepidote, becoming glabrous especially toward apex. Petals obtuse, 15-20 mm. long, about equaling the stamens, blue or violet. COCHABAMBA: CHAPARE: Sacaba, 3000 m., *Kuntze* s. n. (NY; type); Incachaca, 2800 m., *Werdermann* 2006 (B, type of *P. Werdermannii* Harms); TOTORA: Siberia, Comarapa to Pojo, *Vogel* 468 (US). POTOSI: PORCO [?]: Tagua Comuño, 4200 m., *West* 6370 (UC). CHUQUISACA: SUCRE: Guerralona, 3000 m., *Cárdenas* 4128 (US).

43. **P. Brittoniana** Baker, Handbk. Bromel. 124 (1889). Leaf-blades 15-18 mm. wide, glabrous above, sparsely white-lepidote beneath, the spines lax, spreading, uncinate, brown, 5 mm. long. Scape stout. Scape-bracts densely imbricate, the upper ovate with a foliaceous blade, lanate. Inflorescence simple, densely cylindric, over 15 cm. long, densely pale-ferruginous-lanate. Floral bracts ovate, acuminate, 60 mm. long, 38 mm. wide, equaling or exceeding the flowers, entire, thin-coriaceous. Sepals lance-oblong, acute, 22 mm. long, coriaceous. Petals obtuse, 4 cm. long, green. Stamens included. LA PAZ: LARECAJA: Ingenio del Oro between Sorata and Mapiri, 3000 m., *Rusby* 2849 (NY; type).

44. **P. Weddelliana** (Baker) Mez in DC. Monog. Phan. **9:** 475 (1896). Caudex large, forking, stout, bearing rosettes of leaves at the apices of the branches. Leaf-blades 4 cm. wide, glabrous and glaucous above, pale-lepidote beneath, the spines straight, erect, slender, red, 5 mm. long. Scape 1.5 m. high, much exceeding the leaves. Inflorescence amply paniculate, very densely pyramidal, many-flowered. Branches many-flowered and white-tomentose toward base, sterile, bracteate, and glabrous toward apex. Floral bracts lanceolate, acute, 15 mm. long, exceeded by the sepals, entire. Flowers erect. Pedicels 10 mm. long. Sepals subobtuse, 18 mm. long, becoming glabrous. Petals obtuse, 35 mm. long, the blade bright blue. Stamens included. CHUQUISACA: CINTI: Culpina, *Correll et al* B-644 (US); TARIJA:

PROVINCE [?]: *Weddell* 4001 (P; type); MENDEZ: San Lorenzo, 1800 m., *Cárdenas* 210 (GH).

45. **P. Raimondii** Harms in Notizbl. **10:** 213 (1928). "Chuqui Kayara." Plant columnar, 9.5 meters high, dying after the formation of fruit, the caudex simple, erect, 4 m. high, 6 dm. in diameter, surmounted by the dense leaf-rosette. Leaves very many, 1-1.25 m. long, the blades 9 cm. wide, the spines lax, stout, uncinate, dark brown, 10 mm. long. Scape very short and stout, hidden by the leaves. Inflorescence densely bipinnate, slenderly cylindric, attenuate, 4.3 m. long, 6 dm. in diameter, white-lanate throughout. Primary bracts broadly ovate, apiculate, much shorter than the branches, entire, membranaceous, white. Branches spreading or reflexed, sterile toward apex. Floral bracts densely imbricate, ovate-lanceolate, acuminate, exceeding the sepals, membranaceous, subglabrescent. Pedicels cylindric, stout, 15 mm. long. Sepals lanceolate, acute, 4 cm. long. Petals 6-8 cm. long, greenish white, often purplish, the blade broad. La Paz: INGARI: Comanche, 75 km. southwest of La Paz, *Rose* 18875 (NY, US); 4050 m., *M. B. Foster* 2566 (US); COCHABAMBA: CERCADO-CHAPARE: Huacanqui, 3000 m., *Cárdenas* 4380 (US); 2400 m., *M. B. Foster* 2546 (US); TARATA: Tarata, 3900 m., *Miller* (US); TOTORA: Totora, 3800 m., *Cárdenas* 2371 (GH); COCHABAMBA-SUCRE: Cuesta de Alalas, *Furlong* (GH). Peru. Fig. 1.

Excluded Species:

P. boliviensis Baker of Catalogue. Endemic to Chile.

P. micrantha Mez of Catalogue. Endemic to Argentina.

Figure (1)

A: *Puya Raimondii* (after *Cárdenas* 4380), habit from photo; B: section of leaf × 1; C: branch of inflorescence × 1/2; D: flower

TAXONOMY OF *PERITYLE* SECTION *PAPPOTHRIX* (COMPOSITAE — *PERITYLANAE*)[1]

A. MICHAEL POWELL

This small section of the genus *Perityle* is comprised of five species which are distributed throughout Trans-Pecos Texas and in the Organ Mountains of southern New Mexico. Asa Gray (1852) proposed the section to include a species of *Laphamia* (now synonymous with *Perityle*), *L. rupestris*, which exhibited a unique pappus of about 20 bristles.

Rydberg (1914) elevated Gray's section to generic rank, apparently relying on the multi-bristled pappus as the primary distinguishing feature. Other species of *Perityle* have a pappus of 0-2(3) bristles (often 4-6 in *P. staurophylla*) with or without squamellae. Everly (1947), in her revision of *Perityle*, retained *Pappothrix* as a separate genus because the group "can be clearly defined on the basis of a pappus of 15-30 awns." *Pappothrix* indeed is characterized by its pappus, but as Macbride (1918), Shinners (1959), and others have concluded, the distinction does not warrant generic status apart from *Perityle* where pappus variability is a hallmark. Considering most other morphological features *Pappothrix* and *Perityle* are quite similar, and this is substantiated by chromatographic evidence (Powell, 1968a). Sectional status is maintained for *Pappothrix* because the species comprise a natural phyletic unit within *Perityle*. Other information concerning the revised taxonomy of *Perityle* is presented elsewhere (Powell, 1968a).

ECOLOGICAL CONSIDERATIONS

Species of section *Pappothrix*, and in fact most all taxa of the genus *Perityle*, exist in rather bizarre habitats, occurring only in soil-filled crevices of otherwise solid rock.

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I am grateful to the curators of the various herbaria who loaned specimens utilized in this work. I also acknowledge Professor B. L. Turner who suggested the study of *Perityle* and contributed valuable counsel during the course of this investigation.

Plants may be distributed in perpendicular bluffs, large boulders, or any rock mass of considerable size and stability. Plants are never found growing in soil, even among smaller rocks at the base of cliffs. This would appear to represent very stringent conditions for the survival of these plants, especially in the arid southwestern United States. Examination of most populations reveals that a majority of the plants are relatively old, having developed strong, thick woody rootstocks. Dispersal of seeds seems to be effected by fortuitous deposition of achenes by wind and washing from summer thundershowers. No dispersal vectors such as birds or ants have been observed carrying achenes, but it is likely that such animals do spread seeds accidentally.

Plant genera with which the species of *Pappothrix* are commonly associated in their rock habitats are *Heterotheca* spp. and *Hedyotis* spp. Less often associated are *Selaginella* spp., *Galium* spp., *Crotalus lepidus*, and *Cirsium turneri*.

Greenhouse tests of all the section *Pappothrix* species have revealed that they are almost completely self-incompatable. This has facilitated hybridization experiments to the point of determining percent of seed-set, but achene germination is very poor. Manipulation of conditions has shown that dormancy at normal refrigerator temperatures increases the percent of germination about 30%. At present it is difficult to determine if poor germination is due to natural or induced phenomena.

The absence of self-compatability brings out an unresolved question about pollen transfer under natural conditions. Plants in their natural habitat normally produce heads with a very high percent of well-developed achenes. Ants and various other small insects (such as beeflies) have been observed visiting flowers and crawling over plants, but there is no evidence that these animals effect pollination.

There is no apparent regularity with which populations of section *Pappothrix* species are distributed in the hundreds of likely habitats available throughout the total distribution area. The most successful populations are usually located on north and east-facing bluffs or in narrow canyons

where the plants receive only partial sun, but in some areas which appear to offer ideal habitats, plants of these species have not been found. The surface geology of the Trans-Pecos region of Texas and adjacent areas provides important considerations for understanding the distribution of section *Pappothrix* species (Sellards, Adkins, and Plummer, 1958). In general, this region has been subjected to violent geologic events, including intrusive and extrusive Tertiary volcanic activity, cataclismic mountain-forming, faulting, and extensive erosion. Any wide-spread ancestral species of section *Pappothrix* (possibly *P. cernua*) would have become increasingly more isolated with progressive erosion especially because of the restricted habitats. Occupation of new habitats by expanding populations appears to be controlled by fortuitous dispersal, regardless of the desirability of a location. There is some indication that a positive correlation exists between geological events and biological evolution in *Perityle*, but it is not advisable to speculate extensively at this time.

CHROMOSOMAL STUDIES

Meiotic chromosome numbers have been compiled with the utilization of methods similar to those outlined by Turner and Johnston (1961). Voucher specimens are deposited in the Sul Ross State College Herbarium.

Chromosomes of all section *Pappothrix* species are heteromorphic in size, with 2-3 bivalents being smaller and 2-3 bivalents being larger than the others. One or 2 of the smaller bivalents often divide precociously at anaphase I, and thus could lead an observer to believe that unpaired univalents, fragments, or extra chromosomes are occurring. However, careful observation has demonstrated that meiosis is regular in diploid ($n = 17$) and polyploid ($n = 34$, 68, 85) plants.

The chromosome numbers presented in Table I are the first reports for each species of section *Pappothrix*. All species so far examined exhibit diploid chromosome numbers with the exception of *Perityle cinerea*. Diploid and polyploid numbers have been recorded for *P. rupestris*.

Chromosome numbers have not been particularly helpful in determining the interspecific taxonomic relationships within section *Pappothrix* or the affinity of it with sects. *Laphamia* and *Perityle*. The basic number of *Pappothrix* seems clearly established as $x = 17$. Aneuploid numbers above and below $n = 17$ exist in several species of *Perityle* (Powell, 1968b), and it is possible that the ancestral basic number for the genus *Perityle* is $n = 18$ or 19, but the preponderance of species exhibit chromosome numbers of $n = 17$ or polyploids thereof.

Populations of *P. rupestris* seem to possess a remarkable ability to establish polyploidy. Populations with diploid, tetraploid ($n = 34$), octaploid ($n = 68$), and decaploid ($n = 85$) chromosome numbers have been discovered (Table I). The explanation for this high polyploid tolerance is not clear at this time. Perhaps a partial solution is correlated with the stringent ecological conditions under which the species live, and their perennial habit. Also, H.

Table I. Species of *Perityle* section *Pappothrix* Examined for Chromosome Number.

Species	*n* Number	Location and Voucher
Perityle cernua	17 + 1 frag.*	NEW MEXICO: Doña Ana Co. Dripping Springs Canyon. *Sikes & Babcock 328.*
P. cinerea	ca. 68	TEXAS: Pecos Co. 6 mi. e. of Bakersfield. *McKenzie 128.*
	ca. 68	TEXAS: Pecos Co. 7-Mile Mesa, near Ft. Stockton. *Powell 1274.*
P. vitreomontana	17	TEXAS: Brewster Co. n. side, Glass Mts. *Warnock & Powell 19111.*
	17*	TEXAS: Brewster Co. n. side, Glass Mts. *Sikes 110.*
P. quinqueflora	17	TEXAS: Culberson Co. s. McKittrick Canyon, Guad. Mts. *Powell 1246.*
	17	NEW MEXICO: Eddy Co. 6 mi. w. of Whites City. *Powell 1319.*

Species	*n* Number	Location and Voucher
	17*	TEXAS: Jeff Davis Co. ca. 20 mi. w. of FM 2017, San Carlos Tunnel. *Sikes & Babcock 326.*
P. rupestris var. *rupestris*	17	TEXAS: Jeff Davis Co. 17 mi. n. of Alpine. *Powell 1229.*
	17	TEXAS: Jeff Davis Co. Boy Scout Camp, n. of Ft. Davis. *Sikes 33.*
P. rupestris var. *rupestris*	17	TEXAS: Jeff Davis Co. 10 mi. n. of Alpine, near Mitre Peak. *Sikes 4a.*
	ca. 17	TEXAS: Jeff Davis Co. Madera Canyon, n.w. of Ft. Davis. *Sikes 18.*
	34	TEXAS: Jeff Davis Co. Madera Canyon, n.w. of Ft. Davis. *Sikes 17.*
	34	TEXAS: Jeff Davis Co. Madera Canyon, n.w. of Ft. Davis. *Sikes 19.*
	ca. 34	TEXAS: Jeff Davis Co. 2 mi. n. of Ft. Davis. *Powell 1228.*
	34	TEXAS: Jeff Davis Co. Davis Mt. State Park. *Sikes 15.*
	ca. 34	TEXAS: Jeff Davis Co. 6 mi. n.w. of Ft. Davis. *Sikes 16.*
	34	TEXAS: Jeff Davis Co. 6 mi. n.w. of Ft. Davis. *Sikes 15.*
	ca. 34	TEXAS: Jeff Davis Co. Timber Mt., n. of Ft. Davis. *Sikes 45.*
	34	TEXAS: Jeff Davis Co. 16 mi. n. of Alpine. *Powell 1316.*
	34 II + 1 frag.	TEXAS: Jeff Davis Co. 11 mi. n. of Marfa. *Powell 1550.*
	68*	TEXAS: Jeff Davis Co. 13 mi. s. of Toyahvale. *Sikes 91.*

Species	*n* Number	Location and Voucher
P. rupestris var. *albiflora*	17	TEXAS: Brewster Co. 6 mi. n. of Alpine. *Sikes 2.*
	ca. 17	TEXAS: Brewster Co. Basin, Chisos Mts. *Sikes 31.*
	17	TEXAS: Brewster Co. n. side, Cathedral Mt. *Sikes 29.*
	17	TEXAS: Presidio Co. s. side, Goat Mt. *Sikes 48.*
	17	TEXAS: Jeff Davis Co. 10 mi. n. of Alpine, near Mitre Peak. *Sikes 4b.*
	17	TEXAS: Brewster Co. 12 mi. s. of Marathon. *Sikes 20, 21, 22.*
	17*	TEXAS: Brewster Co. 17 mi. s. of Marathon. *Powell 1408.*
	17	TEXAS: Brewster Co. 3 mi. W. of Alpine. *Powell 1320.*
	ca. 34	TEXAS: Presidio Co. 9 mi. s. of Marfa. *Powell 1237.*
	ca. 34	TEXAS: Presidio Co. 10 mi. s. of Marfa. *Powell 1238.*
	34	TEXAS: Presidio Co. n.w. side, Goat Mt. *Sikes 30.*
	ca. 34	TEXAS: Brewster Co. Sunny Glen, 4 mi. w. of Alpine. *Sikes 1.*
	ca. 85	TEXAS: Brewster Co. 12 mi. s.e. of Alpine, Doubtful Canyon. *Sikes 93.*

*Indicates chromosome drawing.

Lewis (1967) has suggested "that autopolyploids may have a tremendous advantage over diploids at the time of the establishment of new colonies from a single normally outcrossing individual." The mechanism for the origin of polyploid populations is not apparent. The close morphic similarity of polyploids and diploids suggests autoploidy as the most logical mechanism, although, as mentioned above, meiosis even in high polyploids appears regular with no

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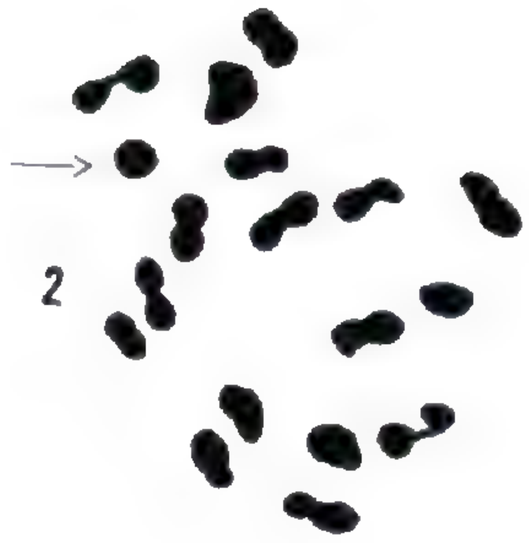
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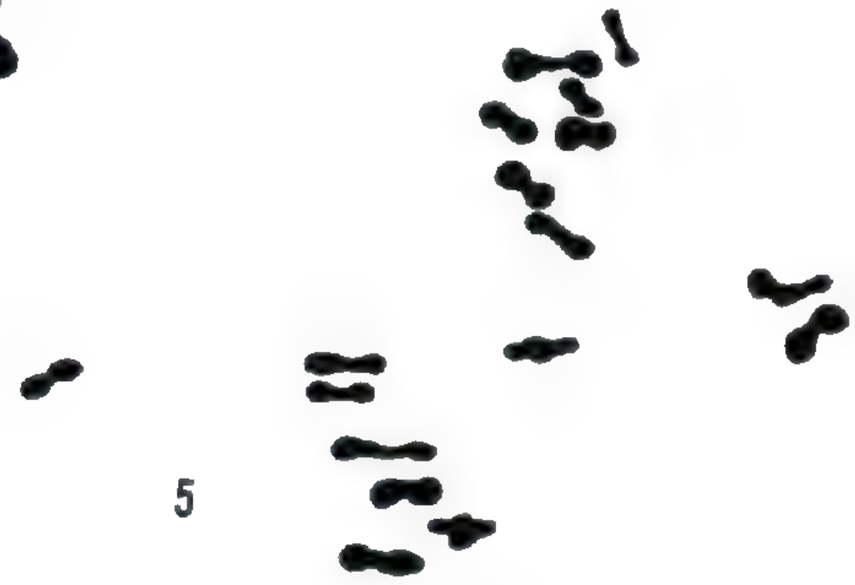
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multivalent configurations observed. However, if all polyploid populations which have been examined are old and well established, it is likely that any meiotic irregularities would have been eliminated. W. Lewis (1967) and H. Lewis (1967) have revived the classic question concerning the potential of "autopolyploids" to evolve as successful populations. Perhaps the polyploids in *Perityle* section *Pappothrix* and *Chamaesaracha* (Solanaceae; Powell and Averett, 1967) could be added to the examples presented by the above authors.

There is no evidence that interspecific hybridization has been responsible for the polyploids. In fact, all species of section *Pappothrix* are strictly allopatric and the topography throughout the total range of these species indicates that separation occurred long ago. *Perityle rupestris* var. *albiflora* is known to occur with *P. parryi* (sect. *Perityle*) in the Chisos Mts. of Texas, and fertile hybrids apparently are produced between the two taxa (Powell, 1968a). *Perityle cinerea* cohabits with *P. angustifolia* (sect. *Laphamia*) on a Cretaceous caprock mesa in eastern Pecos Co. No hybrids between the latter two species have been found.

CHEMICAL STUDIES

Chemical studies were carried out by the use of 2-dimensional paper chromatography following the techniques reported by Alston and Turner (1963). Distinctions in spots were made in accordance with their different positions on chromatograms and their color variation under ultraviolet light with and without the presence of ammonia vapor.

Figures 1-7. Meiotic chromosomes of some *Perityle* section *Pappothrix* species. Fig. 1. *P. cernua*, $n = 17$, *(Sikes & Babcock 328)*. Fig. 2. *P. cernua*, $n = 17$ II + 1 round fragment denoted by an arrow, *(Sikes & Babcock 328)*. Fig. 3. *P. cernua*, $n = 17$ + 1 round fragment (arrow); late anaphase I showing characteristic behavior of fragment, *(Sikes & Babcock 328)*. Fig. 4. *P. vitreomontana*, $n = 17$, *(Sikes 110d)*. Fig. 5. *P. quinqueflora*, $n = 17$, *(Sikes 326b)*. Fig. 6. *P. rupestris* var. *rupestris*, $n = 68$, *(Sikes 91b)*. Fig. 7. *P. rupestris* var. *albiflora*, $n = 17$. *(Powell 1408)*. All × ca. 1300 except for Fig. 3 which is × ca. 1700.

Mere patterns of compounds (probably flavonoids) were employed in the comparison of species, but care was taken to ensure that pattern data were representative of whole populations and not individual plants or seasonal variants (Powell and Tsang, 1966). Each species can be recognized chromatographically by slight differences in patterns (Figs. 8-13). Specific differences are manifested by the consistent presence or absence of unique compounds (oblique lines in Figs. 8-11), and by small combinations of spots which are present in some species but absent in others.

The interpretation of chemical data from *Perityle rupestris* is more difficult because of the occurrence of different patterns for some yellow and white-flowered diploid and polyploid populations of this species (Powell and Tsang, 1966). An understanding of the complex chromatographic variation in *P. rupestris* has not been realized, but after additional testing it is clear that one vexing phenomenon brought out by Powell and Tsang does not hold true in all instances; viz., that diploid white-flowered and polyploid yellow-flowered plants have the ability to produce yellow compounds in much greater abundance than diploid yellow-flowered and polyploid white-flowered plants. A detailed analysis of the chromatographic data obtained for the section *Pappothrix* species will not be possible until a thorough study of the *P. rupestris* complex has been completed. The main purposes of illustrating the chromatographic patterns (Fig. 8-13) are (1) to show the distribution of yellow components among the section *Pappothrix* species, (2) to emphasize the overall similarity of patterns in this subgeneric

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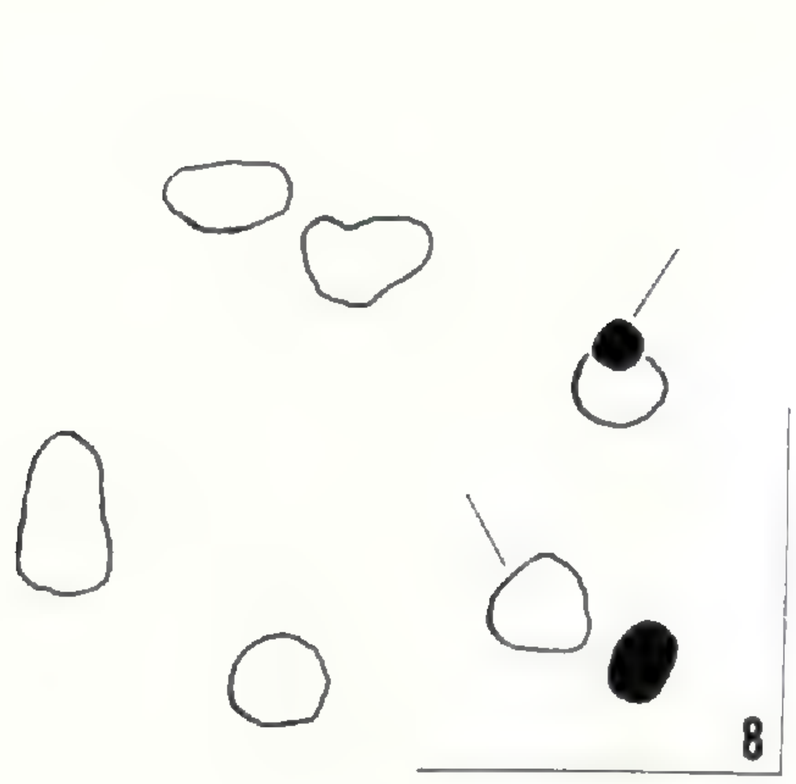
Figures 8-13. Chromatographic patterns of the section *Pappothrix* species of *Perityle*. Fig. 8. *P. cernua*. Fig. 9. *P. vitreomontana*. Fig. 10. *P. cinerea*. Fig. 11. *P. quinqueflora*. Fig. 12. *P. rupestris* var. *rupestris* ($n = 17$). Fig. 13. *P. rupestris* var. *albiflora* ($n = 17$). Darkened spots appear yellow under ultra violet light. Spots which appear to be species specific are denoted by oblique straight lines in association with the spots. No species specific or variety specific spots are designated for *P. rupestris* because the variation in patterns produced by diploid-polyploid populations of this taxon is not well understood.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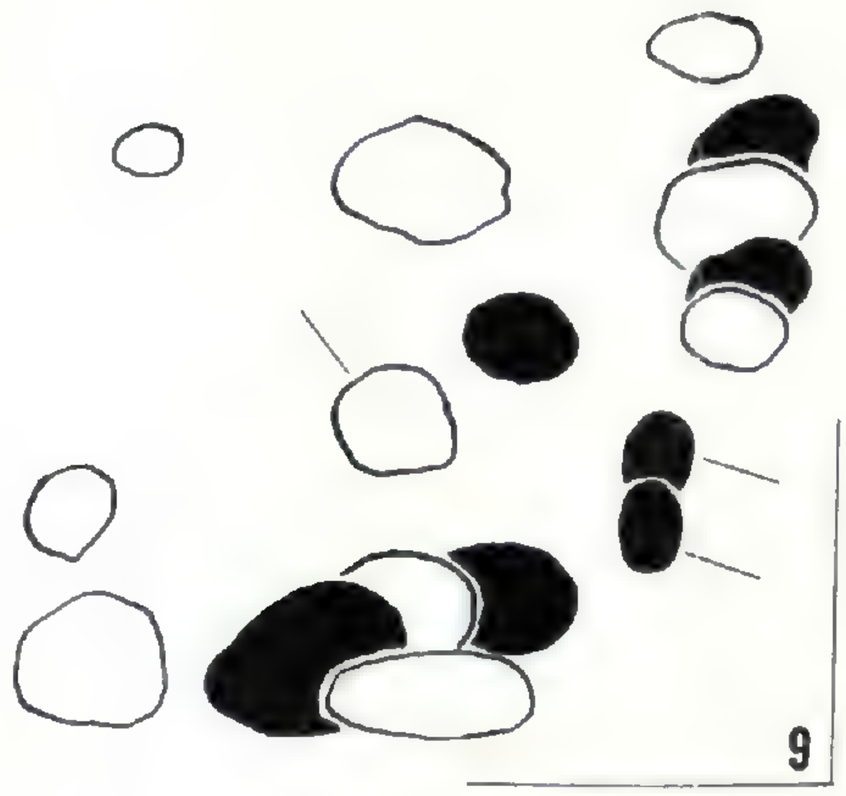
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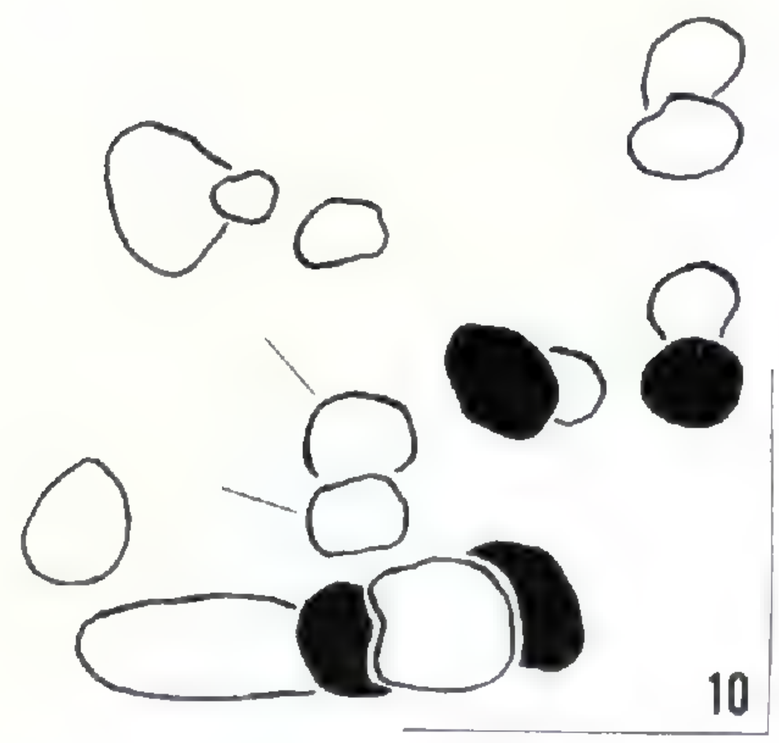
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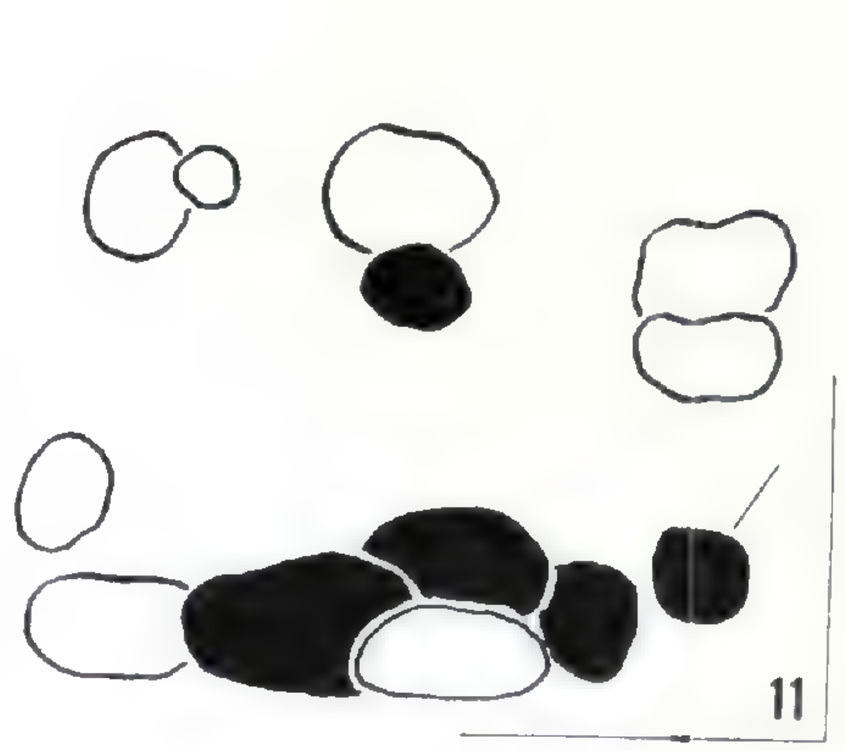
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taxon, and (3) to point out the correlated chemical-morphological distinctiveness of *P. cernua* (Fig. 8). Subsequent discussions based largely on morphic evidence (see Phylogenetic Considerations and Taxonomy) suggest a prominent phyletic distance between *P. cernua* and the other four species of section *Pappothrix*.

The copious yellow components (darkened spots) have proven to represent the basis of the tentative chromatographic profile for the whole genus *Perityle*. Not all species of *Perityle* produce the yellow compounds, but those that do not are considered to be relatively removed from the more primitive species on other grounds. Our current knowledge of these compounds is insufficient to permit more than speculation, but this avenue of investigation appears especially promising.

PHYLOGENETIC CONSIDERATIONS

Section *Pappothrix* stands as a monophyletic assemblage of species within the genus *Perityle*. As discussed earlier the primary unifying character is the pappus of numerous bristles. A connection of section *Pappothrix* with section *Laphamia* is seen through *P. vitreomontana*. The pappus of the latter species is reduced to 2-3 main bristles and numerous vestigial nubs (occasionally several other main bristles are evident). This suggests strongly that section *Pappothrix* is ancestral to section *Laphamia* (at least the Texas species), a subject to be discussed further with the taxonomy of section *Laphamia* (Powell, 1969).

No likely extant precursor to section *Pappothrix* has been discovered. Knowledge of such a taxon would be of theoretical importance because it is possible that a *Pappothrix*-like predecessor fostered the sections *Pappothrix* and *Perityle*. As suggested above, a forerunner of the genus *Perityle* possibly had a chromosome number of $n = 18$ or 19, or maybe even $n = 20$, but at present it appears just as possible that the base number could have been $n = 17$.

It is difficult to predict an ancestral species of section *Pappothrix*, but the progenitor of this phylad must be sought from among *P. cernua*, *P. quinqueflora*, or *P. rupes-*

tris. These three species are basically diploid, yellow-flowered, and produce a well-developed pappus. Of the remaining species, *P. cinerea* is a white-flowered polyploid and *P. vitreomontana* is a white-flowered diploid with a reduced pappus.

The largest number of characters which could be construed as primitive in the section *Pappothrix* line are exhibited by *P. cernua*. These features mainly are solitary, yellow-flowered heads with ca. 150 florets each, large semi-succulent leaves which are glabrous, ca. 35 pappus bristles (compared with 20-30 > 10-14 in other species), and a diploid chromosome number. However, there are factors which might appear to vitiate such a status for *P. cernua*. The species is extremely limited in distribution with a location at the very northwestern periphery of the section *Pappothrix* range. Additionally, chromatographic studies of *P. cernua* have revealed a relatively small quantity of the yellow compounds which are so abundant in other diploid species of this section.

Some factors support the possibility that *Perityle quinqueflora* was the preludial taxon of section *Pappothrix*. Even though the latter species is noted for its numerous reduced heads with 5-6 florets, the leaf morphology is similar to that of *P. cernua* which has what are considered to be the most primitive vegetative features. *Perityle quinqueflora* is a widely distributed diploid species occurring mostly in geologically old limestone areas. Additionally, chromatographic studies have revealed that this species produces yellow compounds in abundance. A few plants in all populations throughout the range of *P. quinqueflora* exhibit heads with 6-8 florets (this is especially true in the population at San Carlos Tunnel in extreme western Jeff Davis Co.), suggesting that reduction in number of florets has been coincident with the evolution of the taxon.

Since plants of *Perityle rupestris* produce heads with 8-12 florets, it is possible to consider this taxon as ancestral to *P. quinqueflora* and perhaps to the other species of section *Pappothrix* as well. However, *P. rupestris* is located mostly in geologically more recent areas than is *P. quinque-*

flora, and the leaves are thinner and more pubescent than are those of the latter species. Even though glabrous conditions might be evolved from pubescent ones in many Composite taxa, this does not seem to have been the case in the derivation of species of section *Pappothrix*. At least in *P. rupestris* a more dense indument seems to be correlated with polyploidy, and the optimum in pubescence of section *Pappothrix* species is seen in the octaploid *P. cinerea*.

When one evaluates the total evidence available, it is apparent that *P. cernua* must be regarded as the ancestral taxon of the section *Pappothrix*. In the first place it would be difficult to visualize how the few, numerous-flowered heads of *P. cernua* could have evolved from a species with numerous 5-12 flowered heads, especially since *P. cernua* is diploid. The determination of the chromosome number of this species was not unequivocal, but certainly the number is $n = 17$ or 18. Regrettably, only one head of buds from this rare species has been available for examination, and it was produced in the greenhouse. I have interpreted the chromosome number to be $n = 17 + 1$ fragment because late anaphase I stages show 17 chromosomes at each pole in many cells, and occasionally 18 at one pole and 17 at the other. A few cells revealed that one chromosome, or portion of a chromosome, was not attached to the spindle apparatus and was left suspended between the poles (Figs. 1-3). Such behavior of chromosome fragments (and univalents) is well known to be associated with reduction in chromosome number. This corresponds with other cytological evidence since there appears to be an aneuploid reduction series in *Perityle* as manifested by several species (Powell, 1968b).

Secondly, the marginal location of *Perityle cernua* within the total section *Pappothrix* range may be construed as enhancing rather than negating a primal position for the taxon. Axelrod (1958) has emphasized that speciation within the general Madro-Tertiary Geoflora was stimulated by adaptation of taxa to drier habitats which came into existence at the margins of deserts. Raven (1964) has discussed catastrophic selection with regard to taxa which become isolated at the peripheries of relatively mesic-xeric habitats.

General principles advanced by both authors appear to fit the proposed evolution of section *Pappothrix* species. Thirdly, it is not yet possible to assess sophisticated conclusions from chemical data. Such data rest ultimately upon the identification of compounds and information regarding their biosynthesis. However, since the obviously more advanced species of section *Pappothrix* (e.g., *Perityle cinerea* and *P. vitreomontana*) produce large amounts of the basic yellow compounds, it is likely that an increased capacity to make the substances is derived. The compounds in question do appear in *P. cernua* but in relatively smaller quantity.

A comparison of present day topography with presumed Late Tertiary geology gives some insight into how the evolution of section *Pappothrix* species could have come about. According to Sellards et al. (1958), a Cretaceous limestone cap extended virtually intact across the Trans-Pecos into New Mexico. With the activity of Tertiary vulcanism and subsequent erosion, many of the rock-bluff potential habitats of section *Pappothrix* species progressively must have become more disjunct. Assuming that the distribution of an ancestral species with vegetative and floral morphology approaching present day *P. cernua* became widespread across an ecologically uniform area before the mountain chains were well separated, the stage would have been set for speciation through geographical isolation. Later erosion could have accounted for more rapid and complete isolation of existing populations such as we see today in the Trans-Pecos. The restriction of section *Pappothrix* species habitats to mountain regions and other prominent land features (such as remnants of limestone caprocks) seems to support such an evolution of taxa.

The broken mountain systems which extend from southern New Mexico through the Trans-Pecos into Mexico apparently were once continuous enough to allow the establishment of a mesophytic montane forest in the higher altitudes, although Wells (1966) has suggested that many of the mesophytic species have never existed in continuum between some of the mountains. All species of section *Pappothrix* occur at various altitudes in these mountains, ex-

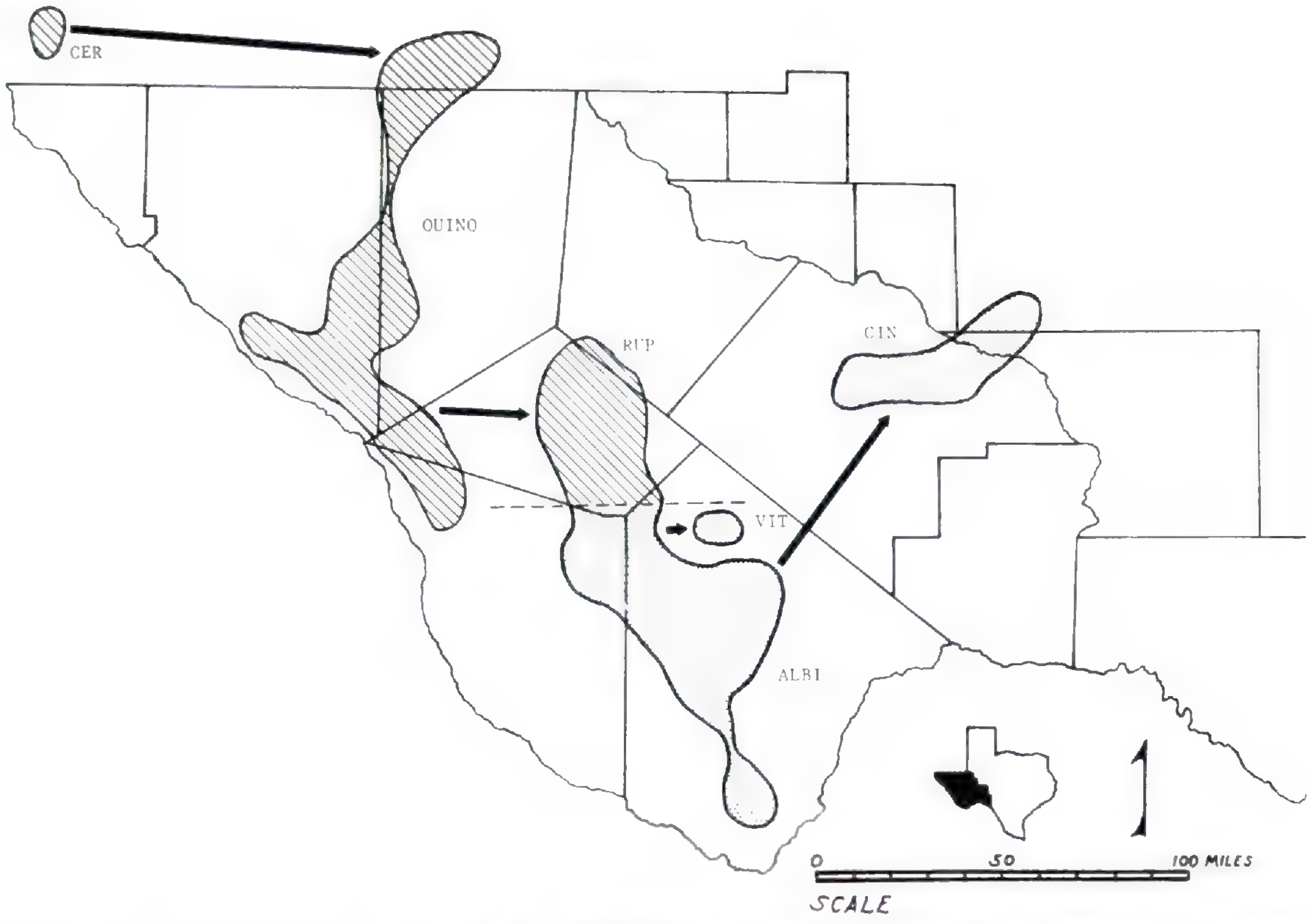

Fig. 14. Supposed evolutionary sequence of *Peritule* section of *Pappothrix* species. Present day distribution of the yellow-flowered taxa *P. cernua* (CER), *P. quinqueflora* (QUINQ), and *P. rupestris* var. *rupestris* (RUP) is indicated by diagonal lines. Stippled areas designate the ranges of white-flowered *P. rupestris* var. *albiflora* (ALBI), *P. vitreomontana* (VIT), and *P. cinerea* (CIN). The distributional areas of *P. cernua* and *P. vitreomontana* are greatly exaggerated here. Arrows show the probable direction of species development. Relatively speaking, mesic habitats of these species are located in the Organ Mts. *(P. cernua)*, Guadalue Mts. (northern extreme of *P. quinqueflora* range), Davis Mts. (central *P. rupestris* var. *rupestris* range), and Chisos Mts. (southern extreme of *P. rupestris* var. *albiflora* range). All other areas are relatively xeric.

cept *Perityle cinerea*, and it is probable that conditions at least were conducive to the migration of a precursoral taxon. Assuming first of all that section *Pappothrix* represents a northeastern fringe element of the Madro-Tertiary Geoflora, Figure 14 shows how the various section *Pappothrix* species could have arisen after distribution along the mountains in which they are now located from northern into more southern areas. Presumably *Perityle cernua* represents a relictual mesophytic population of ancestral section *Pappothrix* which migrated into the southerly mountains when relatively moist environments prevailed. Since the floral features of *Perityle cernua* (large, solitary heads) differ so markedly from those of *P. quinqueflora* and *P. rupestris*, it is conceivable that a prototype of the latter taxa developed the characteristic smaller, numerous heads long before their divergence as separate species. On the basis of the above postulate, it would follow that *P. cernua* has been isolated much longer than have *P. quinqueflora* and *P. rupestris*. Possibly the latter species gradually became isolated through erosion of their elevated habitats and subsequently becoming adapted to the more xeric habitats in which they now occur. For example, the northernmost population of *P. quinqueflora* in the Guadalupe Mts. resembles *P. cernua* in vegetative habit, and a southernmost population at San Carlos Tunnel resembles *P. rupestris* in the same way. Probably, the San Carlos population of *P. quinqueflora* was most recently isolated from *P. rupestris*. The northernmost populations of *P. rupestris* are more like *P. quinqueflora* vegetatively than the more xerophytic southern populations of this species to the south. It is reasonably certain that yellow-flowered *P. rupestris* preceded the origin of white-flowered *P. rupestris* var. *albiflora*. White-flowered populations are distributed entirely south of the yellow-flowered colonies in somewhat drier habitats (Figure 14).

The white-flowered *Perityle cinerea* and *P. vitreomontana* apparently evolved from offshoots of the white-flowered line arising out of *P. rupestris*. That an ancestral taxon might have given rise to two separate species independently is suggestive of a similar circumstance reported in *Chaenac-*

tis by Kyhos (1965). With these section *Pappothrix* species, however, geographic separation is proposed as the mechanism of initial isolation rather than the aneuploid reduction of chromosome number and structural rearrangements of chromosomes which occurred in *Chaenactis*. *Perityle cinerea* could have originated from a population which migrated into the present Cretaceous caprock area at a time when a more mesic and continuous environment existed throughout the region. Wells (1966) has discovered that pinyon pine was present across the same general territory as recent as Pleistocene. Both *P. cinerea* and *P. vitreomontana* seem to be manifestations of differential adaptation to more xeric habitats. *P. cinerea* has become established as a octaploid species, while *P. vitreomontana* developed as a semi-depauperate diploid species.

If speculations about the ramification of *Perityle cinerea* and *P. vitreomontana* are accurate, an interesting question remains about why their older phylogenetic antecedent did not diverge to a similar degree. Current distribution of the three taxa would suggest that *P. rupestris* var. *albiflora* was never disassociated from *P. rupestris* var. *rupestris*, and their relatively uniform environments, as were *P. cinerea* and *P. vitreomontana*.

Morphological evidences of the relationships projected above can be gleaned from the taxonomic discussions which follow.

TAXONOMY

Perityle sect. *Pappothrix* A. Gray, Pl. Wright. 1: 100. 1852.
Pappothrix (A. Gray) Rydb., N. Amer. Fl. 34: 26. 1914.
TYPE: **Laphamia rupestris** A. Gray.

Plants small suffrutescent perennials, or the stems herbaceous and brittle, growing in crevices of limestone or igneous rock bluffs, glabrous, puberulent, hirsute, pilose, or tomentose-canescent; leaves alternate or opposite, 1.0-4.0 cm long, 0.6-3.0 cm wide, ovate, reniform, or cordate, entire to serrate or serrate-lobed; inflorescence of solitary and erect or nodding heads, or several erect heads, partially obscured by leaves; heads broadly to narrowly campanulate or subcylindric, 0.4-1.4 cm wide; involucre of 2 equal or subequal series; ray flowers absent; disc flowers 5-150; disc corollas yellow or white; style branches linear, tapering to a minutely pubescent point; achenes black, 1.8-

3.0 mm long, oblong to narrowly obconical, partially flattened to subcylindric, usually rounded or angled on one or both surfaces, with rather inconspicuous calloused margins, the margins, angles, and surfaces short-pubescent; pappus of (2-7)10-35 slender, unequal bristles, 1.0-3.5 mm long, minutely antrorse-ciliate; base chromosome number, $x = 17$.

Since the taxonomy of the other two sections of *Perityle* will be published separately, a key to all three sections is presented here to facilitate the identification of each subgeneric group.

KEY TO THE SECTIONS

Pappus of (2-7-)10-35 bristles; achenes subcylindrical to partially flattened, margins short-pubescent. ..... sect. *Pappothrix.*

Pappus of 0-2(-3-6) bristles; achenes flattened, margins short-pubescent or profusely ciliate.

Pappus of bristles only (rarely none) or with inconspicuous, vestigial squamellae; achene margins sparsely short-pubescent. .... sect. *Laphamia.*

Pappus of bristles (rarely none) and a crown of squamellae; achene margins profusely ciliate. ..... sect. *Perityle.*

KEY TO THE SPECIES OF *PERITYLE* SECTION *PAPPOTHRIX*

Heads large, florets ca. 150; corollas yellow; Organ Mts., New Mexico. ..... 1. *P. cernua.*

Heads small, florets 5-16(20); corollas yellow or white.

Florets 5-6(7-8); leaves somewhat lustrous, dark olive-green, subsucculent to coriaceous, typically reniform to subreniform, essentially glabrous to puberulent, rarely hirtellous. .... 2. *P. quinqueflora.*

Florets (7)8-16(20); leaves lighter green, rather thin, typically ovate, subdeltoid, to subcordate, notably pubescent.

Corollas yellow or white; pappus of 20-30 well-developed bristles; leaves pilose to hirsute; widely distributed in igneous or limestone rocks in Davis Mts., Texas.

Corollas yellow. ..... 3a. *P. rupestris* var. *rupestris.*

Corollas white. ..... 3b. *P. rupestris* var. *albiflora.*

Corollas white; pappus reduced or well-developed; leaves pilose to tomentose-canescent.

Pappus reduced to 2-3(6) main bristles, less often 10-20, including vestigial nubs; leaves pilose; Glass Mts., Texas. ..... 4. *P. vitreomontana.*

Pappus of 14-20 well-developed bristles; leaves tomentose-canescent; Cretaceous limestone, Pecos, and Upton Counties, Texas. ..... 5. *P. cinerea.*

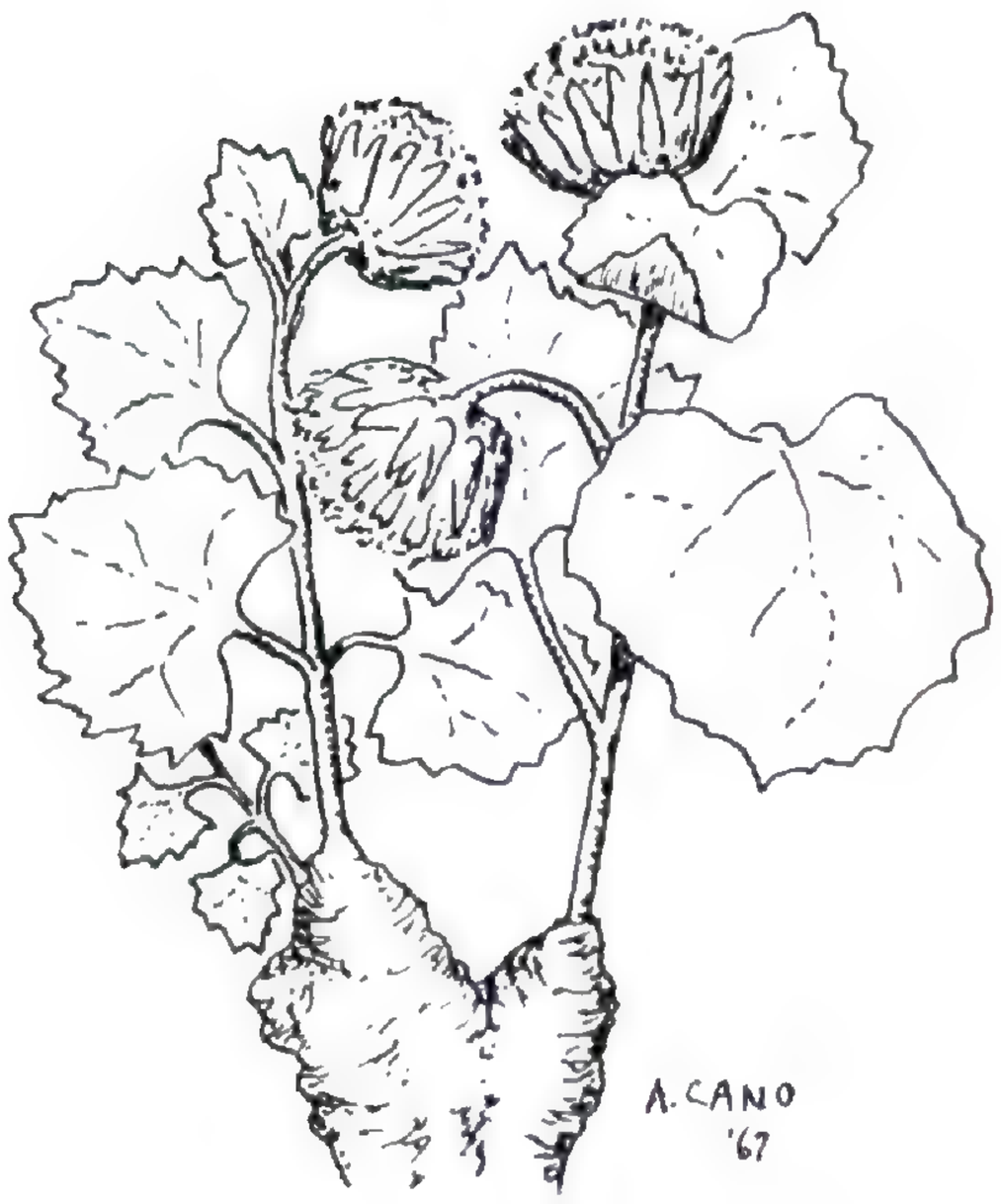

Figure 15. Habit sketch of *Perityle cernua (Sikes 65)*; × 1.

1. **Perityle cernua** (Greene) Shinners, Southw. Nat. **4**: 204-209. 1959. Fig. 15.

Laphamia cernua Greene, Bull. Torr. Bot. Club **25**: 122. 1898. TYPE: *NEW MEXICO*: DOÑA ANA Co: Organ Mts., at 6500 ft., 4 Sept. 1897, *E. O. Wooton 476*? (Holotype, ND-G! Isotypes US!).

Pappothrix cernua (Greene) Rydb. N. Amer. Fl. 34: 27. 1914.

Plants 3-6 cm high, closely appressed to rocks, essentially glabrous, dark, lustrous green; leaves alternate or opposite on very short stems, the leaves 2.3-4.0 cm long, 2.0-3.0 cm wide, ovate-reniform to ovate-cordate, the margins unevenly serrate-dentate, essentially glabrous; petioles 0.7-1.5 cm long; inflorescence of solitary and erect or nodding heads often partially obscured by leaves, the peduncles 1.0-1.9 cm long; heads broad-campanulate, 1.0-1.2 cm long, 1.2-1.4 cm wide; receptacle convex, rounded, 3.0-4.0 mm wide, ca. 2.0 mm high; bracts ca. 28, 8-9 mm long, 1.3-1.5 mm wide, linear-lanceolate; disc flowers ca. 150; disc corollas golden yellow, 5.5-6.0 mm long, the tube 1.7-2.0 mm long, minutely glandular-pubescent, the throat narrowly funnelform, 2.8-3.3 mm long, sparsely glandular-pubescent, the lobes narrow, acute, 0.7-0.8 mm long; achenes 2.1-2.5 mm long, partially flattened; pappus of ca. 35 slender, unequal bristles, 1.2-1.5(2.0) mm long, minutely antrorse-ciliate; anthers 2.0-2.5 mm long; chromosome number, $n = 17\ II + 1$ frag.

An extremely rare endemic species, known only from the type locality at Dripping Springs Canyon, growing in lime-

stone rock walls, w. side, Organ Mountains, Doña Ana County, New Mexico. Spring-Fall. (Fig. 17).

Representative Specimens:

NEW MEXICO: Doña Ana Co: Organ Mts., 29 Aug. 1894, *E. O. Wooton s. n.* (US); n. face of Dripping Springs Canyon, 12 mi. e. of Las Cruces, Organ Mts., *S. Sikes 65* (SRSC): Dripping Springs Canyon, Organ Mts., 10 May 1967, *S. Sikes and C. Babcock 328* (SRSC).

The most anomalous species of section *Pappothrix* is *Perityle cernua*. Easily recognized by its small habit, large, solitary heads, and relatively large leaves, *P. cernua* is not easy to relate to other species. This is true mainly because there are no extant section *Pappothrix* species with such large heads. It is probable that *P. cernua* represents the ancestral species of section *Pappothrix*, exhibiting such primitive characters as yellow flowers, few, large heads with numerous florets, and large, glabrous, thick leaves. Vegetatively, notwithstanding the large heads, *P. cernua* appears closest to *P. quinqueflora*.

Figure 16. Habit sketch of *Perityle quinqueflora (Powell 1319)*; × 1.

2. **Perityle quinqueflora** (Steyermark) Shinners, Southw. Nat. 4: 205. 1959. Fig. 16.

Laphamia quinqueflora Steyermark, Ann. Mo. Bot. Garden **19:** 392, 393. 1932. TYPE: TEXAS: CULBERSON Co: niches in exposed limestone cliffs, lower McKittrick Canyon, Guadalupe Mts., alt. 1900 m., 20 July 1931, *Moore and Steyermark 3547* (Holotype, GH! Isotypes, CAS! DS! UC! US!).

Pappothrix quinqueflora (Steyermark) Everly, Contrib. Dudley Herb. 3: 375-396. 1947.

Plants 7-30 cm high, densely leafy, essentially glabrous to puberulent; leaves opposite, often becoming alternate above, 1.5-2.5(3.8) cm long, 0.8-2.0(3.3) cm wide, subsucculent to coriaceous, somewhat lustrous, dark olive-green, typically reniform to subreniform, sometimes short-cordate, the margins subentire, dentate-toothed or shallow-lobed, the teeth lobes typically obtuse or rounded but rarely acute, apex obtuse, rounded, or rarely subacute, subcuneate at the base, essentially glabrous to puberulent, rarely hirtellous; petioles 5-8(12) mm long; inflorescence typically of several to many heads in a cluster, borne on rather slender peduncles 2-10(15) mm long; heads cylindrical to very narrowly campanulate, 7-8(9) mm long, 2-3 mm wide, often partially obscured by leaves; receptacle flattened to slightly convex, ca. 1.0 mm wide; involucre of 5-6 bracts in essentially one series, 5-6(9) mm long, (1.0)1.3-1.7 mm wide, strongly keeled; disc florets 5-6(8); disc corollas yellow, 3.8-4.3 (rarely 5.0) mm long, the tube 1.0-1.3 mm long, minutely glandular-pubescent, the throat tubular, 2.0-2.3 (rarely 2.8) mm long, sparsely glandular-pubescent, the lobes acute, reflexed 0.5-1.0 mm long; achenes 1.9-2.0 (rarely 2.5-2.9) mm long, flattened; pappus of 25-30 slender bristles, 1.9-2.5(3.5) mm long, the bristles unequal in length, minutely antrorse-ciliate; anthers 1.5-2.0 mm long; chromosome number, $n = 17$.

Growing extensively in crevices of limestone bluffs (rarely igneous in the Sierra Vieja and Eagle Mts.), in high canyons and caprock. Spring-Fall. (Fig. 17).

Representative Specimens:

NEW MEXICO: EDDY Co: Guadalupe Mts., 12 July 1939, *A. L. Hershey 619* (CAS); crevices of limestone rock in canyon to Carlsbad Caverns, 30 May 1965, *A. M. Powell 1319* (SRSC); s.w. portion of Dark Canyon, Guadalupe Mts., 1 Sept. 1965, *Powell & Sikes 1379* (SRSC). CULBERSON Co: Pine Canyon, Guadalupe Mts., 20 June 1964, *D. S. Correll & C. Hanson 29791* (LL); South McKittrick Canyon, 2 July 1958, *Correll & I. M. Johnston 19177* (LL); Beach Mts., 8 mi. n. of Van Horn, 3 June 1938, *H. C. Cutler 1978* (CAS); South McKittrick Canyon, 25 Aug. 1950, *W. V. Fischer s.n.* (UC); South McKittrick Canyon, 11 July 1948, *L. C. Hinckley 4467* (SRSC); upper McKittrick Canyon, 21 June 1947, *F. G. Meyer & L. E. Meyer 2178* (UC); between

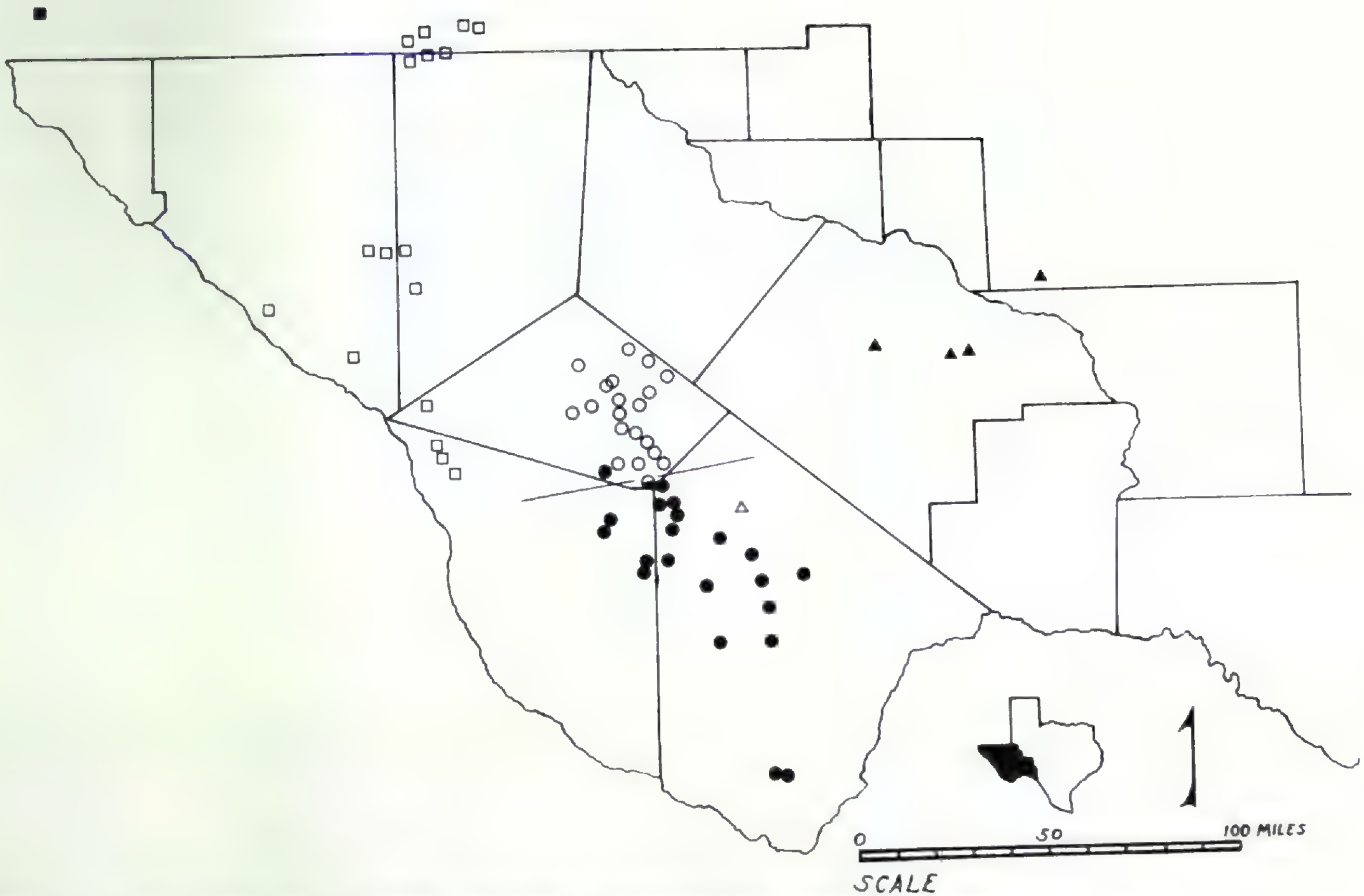

Figure 17. Distribution of *Perityle* section *Pappothrix* species: *P. cernua* (closed square, Organ Mts., N. M.); *P. quinqueflora* (open squares); *P. rupestris* var. *rupestris* (open circles); *P. rupestris* var. *albiflora* (closed circles); *P. vitreomontana* (open triangle); *P. cinerea* (closed triangle). A solid line emphasizes the discontinuity of the varieties of *P. rupestris*; the location of a sympatric population is denoted by a half-closed circle.

South & North McKittrick Canyons, 15 July 1945, *R. McVaugh 7398* (LL, SMU); Smith Canyon, Guadalupe Mts., 17 July 1945, *R. McVaugh 7418* (LL, SMU); South McKittrick Canyon, 4 July 1964, *A. M. Powell, B. Calvert, & P. Tsang 1246* (SRSC); Victoria Canyon, Sierra Diablo, 10 Aug. 1946, *L. H. Shinners 8865* (SMU, TEX); Pine Springs Canyon, Guadalupe Mts., 15 Aug. 1946, *Shinners 9062* (SMU); McKittrick Canyon, 15-17 Aug. 1924, *P. C. Standley 40562* (US); upper Pine Springs Canyon, 15 Sept. 1948, *B. L. Turner & B. H. Warnock 123* (LL, SMU, SRSC); Smith Canyon, 10 July 1949, *Turner and Warnock 1265* (SMU, SRSC); McKittrick Canyon, 30 Aug. 1950, *Warnock 9456* (LL, SRSC); Victoria Canyon, Diablo Mts., 11 July 1956, *Warnock 14091* (LL, SRSC); South McKittrick Canyon, 11 Sept. 1962, *Warnock 20407* (SRSC); South McKittrick Canyon, 18 May 1958, *Warnock & M. C. Johnston 16529* (SRSC); lower Pipe Line Canyon, 5 July 1958, *Warnock & Johnston 16589* (SRSC); North McKittrick Canyon, 4 Aug. 1962, *Warnock & T. Rogers 18864* (SRSC); Pine Top Mt., 28-29 July 1952, *G. L. Webster 4578* (SRSC); Guadalupe Mts., 15 Aug. 1916, *M. S. Young s.n.* (TEX); Guadalupe Mts., 2 Sept. 1916, *M. S. Young s.n.* (TEX, SRSC). HUDSPETH CO: Quitman Canyon, Quitman Mts., 13 Oct. 1952, *D. S. Correll 15065* (LL); s. Sierra Diablo Plateau, 9 Sept. 1961, *Correll & Johnston 24362* (LL); upper limestone slopes, Victoria Canyon, 10 July 1945, *R. McVaugh 7359* (LL, SMU); Van Horn, 4 Sept. 1925, *B. C. Tharp 3818* (TEX); head of Victoria Canyon, 18 Aug. 1953, *Warnock 11495* (SRSC); s.e. of Old Love Ranch, Eagle Mts., 22 Aug. 1946, *U. T. Waterfall 6684* (NY). JEFF DAVIS CO: San Carlos Tunnel, 22 July 1967, *Powell & Sikes 1536* (SRSC); ca. 20 mi. w. of FM 2017, San Carlos Tunnel, 11 May 1967, *Sikes & Babcock 326* (SRSC). PRESIDIO CO: Bracks Canyon, Sierra Tierra Vieja, 11 June 1941, *L. C. Hinckley 1675* (SMU, TEX, US); near rimrock, Sierra Tierra Vieja, 4 Oct. 1941, *Hinckley 2185* (LL, NY); Vieja Pass, Vieja Mts., 3 Aug. 1960, *Warnock 19600* (SRSC).

It is clear that *Perityle quinqueflora* is most closely related to *P. rupestris*. In fact, the several collections from Sierra Tierra Vieja (Jeff Davis Co. and Presidio Co.) are difficult to distinguish from *P. rupestris*. Normally *P. quinqueflora* is readily distinguished from *P. rupestris* by 5(6) flowered heads, 5(6) involucral bracts, rather fleshy, dark green, subglabrous leaves with margins varying from subentire to serrate-lobed, and habitat mainly in limestone rock. The Sierra Vieja collections at San Carlos Tunnel approach *P. rupestris* by exhibiting 5-7(8) florets and bracts per head, and thinner, lighter green, hirtellous leaves with deep serrations of the leaf margins. Even though the Sierra Vieja population closes the morphological gap between these

two taxa, there is no evidence of intergradation. Geographically *P. quinqueflora* and *P. rupestris* remain well separated (Fig. 17).

It is interesting to speculate about the phylogeny of these related entities. *Perityle quinqueflora* features several reduced characters, especially the 5-membered heads and essentially glabrous habit, and could thus be viewed as derived from *P. rupestris*. However, the former species is distributed in the geologically older areas, for the most part, and is known only as a diploid. *Perityle rupestris* on the other hand, at least the yellow-flowered variety, occupies the geologically more recent tertiary igneous intrusive and extrusive formations in Jeff Davis Co., and occurs in diploid and polyploid forms. The white-flowered variety of *P. rupestris* inhabits both limestone and igneous formations.

As discussed above, most evidence concerning the relationship of *P. quinqueflora* and *P. rupestris* seems to indicate an evolution of both species from a widespread ancestor much like *P. cernua*. Hypothetically, two large populations could have been isolated geographically in recent geological history when their relatively continuous rock-bluff habitats were eroded away. Once they were separated the populations would have been free to follow their independent evolutionary paths. It is possible that a fluctuating Pleistocene environment could have allowed secondary sympatry after initial isolation if erosion of intermediate habitats was not complete. There is no evidence for the latter unless one considers the somewhat morphologically intermediate colony of *P. quinqueflora* at San Carlos Tunnel to have resulted from hybridization with *P. rupestris*. At this time it appears feasible to interpret the San Carlos population as one which has been most recently segregated from *P. rupestris*.

3a. **Perityle rupestris** (Gray) Shinners var. **rupestris**, Southw. Nat. 4: 204-209. 1959. Fig. 18.

Laphamia rupestris Gray, Pl. Wright. 1: 100. 1852. TYPE: TEXAS: JEFF DAVIS CO: crevices of rocks, on mountains, in the Pass of the Limpia, Aug. 1849, *Charles Wright 300*

(Holotype, GH! Isotypes, GH! NY! US! Photograph, DS!).
Pappothrix rupestris (Gray) Rydb. N. Amer. Fl. 34: 26. 1914.

Plants 6-20(35) cm high, puberulent, pilose, or hirsute, profusely branched and leafy; leaves opposite or alternate, usually alternate, 1.0-2.5(3.5) cm long, 0.7-1.7(3.0) cm wide, ovate to broadly so, subdeltoid, subcordate, or rarely subreniform, the margins irregularly serrate or serrate-lobed, the serrations or lobes acute (rarely obtuse), pilose, hirsute, or rarely puberulent; petioles 0.3-1.3 cm long; inflorescence of solitary heads or small, loose clusters, heads borne on rather short peduncles, often partially obscured by leaves; receptacles flattened to slightly convex, 1.0-1.5 mm wide; heads subcylindric, subfunnelform, or narrowly companulate, 6-8 mm long, 3-5 mm wide; bracts 8-10, 4-7 mm long, 1-2 mm wide, typically oblong to oblong-lanceolate, keeled; disc flowers (7) 8-12; disc corollas yellow, 4.0-5.2 mm long, the tube 1.0-1.3 mm long, minutely glandular-pubescent, the throat tubular to subfunnelform, 2.2-3.0 mm long, the lobes acute, 1.0-1.3 mm long; achenes (1.8) 2.0-2.5 mm long, subtruncate or tapering toward the base, flattened (rarely nearly cylindric); pappus of 20-30 slender, unequal, bristles, 2.0-3.0(3.5) mm long; anthers 2.0-2.5 mm long; chromosome numbers, $n = 17, 34, 68$.

An extremely variable taxon, common in crevices of igneous boulders and bluffs, from ca. 10 mi. north of Alpine

Figure 18. Habit sketch of *Perityle rupestris* var. *rupestris (Powell 1228)*; × 1.

throughout Jeff Davis County and probably north Presidio County. Spring-Fall. (Fig. 17).

No mention of flower color was made in Gray's original description of *Laphamia rupestris*, but the morphology of the type specimens and Wright's collection site indicate that this is a member of the yellow-flowered variety.

Representative Specimens:

TEXAS: JEFF DAVIS CO: e. slope, Haystack Mt., 6050 ft., 27 May 1959, *T. J. Allen 353* (SRSC); 10 mi. s.e. of Ft. Davis, 28 April 1947, *V. L. Cory 53568* (NY, SMU); Fort Davis, 19 Sept. 1920, *W. W. Eggleston 17425* (NY, US); Fort Davis, 20 Sept. 1920, *Eggleston 17474* (NY, US); rocky hillside back of old Ft. Davis, 9-12 July 1921, *R. S. Ferris & C. D. Duncan 2683* (DS); 12 mi. n. of Alpine, 18 Oct. 1933, *H. T. Fletcher 1482* (SRSC); Goat Canyon, Mt. Livermore, 7 Sept. 1935, *L. C. Hinckley s.n.* (TEX); n. side of Timber Mt., near Madera Springs, 24 July 1949, *L. C. Hinckley & L. Hinckley 19?* (SMU, SRSC); Limpia Canyon at Wild Rose Pass, 11 Sept. 194?, *Hinckley & Hinckley 338* (SRSC); ridge s. of Mt. Livermore, 21 Aug. 1935, *Hinckley 356* (LL); Mt. Livermore, Aug., 1935, *Hinckley 50?* (SRSC); Limpia Canyon near Ft. Davis, 8 Oct. 1944, *Hinckley 338?* (SRSC); igneous rock above old Ft. Davis, 6 Nov. 1958, *M. C. Johnston 3578* (SRSC); igneous rock, 18 mi. n. of Alpine, 6 Nov. 1958, *Johnston 3589* (SRSC); 15 mi. n. e. of Ft. Davis, canyon e. of Limpia Creek, 24 May 1949, *R. McVaugh 10626* (SRSC, US); Little Aguja Canyon, 12 June 1931, *J. A. Moore & J. A. Steyermark 3041* (CAS, DS, NY, UC, US); clefts and ledges of porphyritic rocks, Davis Mts., 7 Oct. 1926, *E. J. Palmer 32029* (TEX); crevices in basaltric rocks, on the Limpia, *C. C. Parry s.n.* (NY); ca. 2 mi. n. of Ft. Davis along Limpia Creek, 6 June 1964, *A.M. Powell & B. Calvert 1228* (SRSC); ca. 17 mi. n. of Alpine along Musquiz Creek, 6 June 1964, *Powell & Calvert 1229* (SRSC); large igneous boulders, 16 mi. n. of Alpine, 14 May 1965, *A. M. Powell & P. R. Powell 1316* (SRSC); 11 mi. n. of Marfa, 19 Aug. 1967, *Powell 1550* (SRSC); 10 mi. n. of Alpine, near Mitre Peak, 5 June 1965, *S. Sikes 4a* (SRSC); Davis Mt. State Park, 3 Sept. 1965, *Sikes 15* (SRSC); 6 mi. n. w. of Ft. Davis, 3 Sept. 1965, *Sikes 15, 16* (SRSC); Madera Canyon, n. w. of Ft. Davis, 3 Sept. 1965, *Sikes 17, 18, 19* (SRSC); Boy Scout Camp n. of Ft. Davis, 30 Sept. 1965, *Sikes 33* (SRSC); Timber Mt., n. of Ft. Davis, 5 June 1966, *Sikes 45* (SRSC); 13 mi. s. of Toyahvale, 28 Aug. 1966, *Sikes 91* (SRSC); rock crevices, Fern Canyon, 20 Oct. 1945, *O. Sperry T1322* (US); Fern Canyon, Aug. 1932, *T. L. Steiger 954* (NY); lower Limpia Canyon, 9 May 1937, *B. H. Warnock T80* (TEX, US); Musquiz Canyon, 16 mi. n. of Alpine, 19 June 1947, *Warnock 6158* (SRSC); n. slopes of Timber Mt. above Madera Springs, 20 July 1947, *Warnock 6493*

(SRSC); upper Madera Canyon, Mt. Livermore, 11 Sept. 1947, *Warnock & Hinckley 7458* (SRSC); upper Madera Canyon, 25 Oct. 1947, *Warnock 7619* (SRSC); Wild Rose Pass, Limpia Canyon, 24 May 1949, *Warnock & McVaugh 8649* (SRSC); n. side Timber Mt., 14 May 1950, *Warnock & N. Tallant 9058* (SRSC); 12 mi. n. of Alpine, 13 Sept. 1963, *Warnock & Powell 19289* (SRSC); 12 mi. n. of Alpine, 11 Sept. 1962, *Warnock 20404* (SRSC); 15 mi. n. of Alpine, upper Rose Canyon, 1 July 1940, *Warnock 20909* (TEX); 20 mi. s. s. e. of Kent, 31 July 1943, *U. T. Waterfall 5406* (CAS, NY); Davis Mt. Park, 23 June 1941, *E. Whitehouse 12129* (SMU); Mt. Livermore, 14 Aug. 1914, *M. S. Young s. n.* (TEX).

3b. **Perityle rupestris** (Gray) Shinners var. **albiflora** Powell, Sida **3:** 180. 1967. TYPE: TEXAS: BREWSTER CO: in crevices of igneous bluffs, ca. 3 mi. w. of Alpine in Tronto Pass, 3 June 1965, *A. M. Powell & S. Sikes 1320* (Holotype, SRSC; isotypes, GH, SMU, TEX, US).

Disc corollas white; disc florets 8-18; achenes 1.8-2.5 mm. long; pappus bristles 18-25, 1.0-2.0 mm. long; chromosome numbers, $n = 17$, 34, 85.

A variable taxon, common in crevices of igneous and limestone bluffs and boulders, from ca. 10 mi. n. of Alpine, south throughout Brewster County, extreme south Jeff Davis County, and eastern Presidio County.

This variety is distinguished by white disc corollas, smaller leaves in most populations, tendency for more florets per head, pappus bristles mostly as long as or shorter than the achenes, and geographic distribution (Fig. 17).

Representative Specimens:

TEXAS: BREWSTER CO: ca. 15 mi. s. e. of Marathon, 13 Sept. 1961, *D. S. Correll & M. C. Johnston 24577* (LL); Pena Blanca Mts., 6 mi. e. of Hwy. 385, 30 Sept. 1962, *Correll & H. B. Correll 26109* (LL); Pine Canyon, Chisos Mts., 17 June 1963, *Correll & D. C. Wasshausen 27867* (LL); vicinity of Alpine, 7 June 1926, *D. Demaree & E. J. Palmer 104* (SMU); n. slope, Cathedral Mt., 21 July 1960, *L. Doyles & B. Jobes 71* (SRSC); Lizzard Mt., 2 mi. w. of Alpine, 21 Sept. 1934, *H. T. Fletcher 144* (SRSC); Lizzard Mt., 10 Sept. 1929, *Fletcher 1384* (SRSC); s. end of Del Norte Mts., 6 Sept. 1947, *L. C. Hinckley & F. M. Churchill 4112* (SMU, US); Alpine, 3 Oct. 1930, *R. Hughes 12* (NY); upper slopes Cathedral Mts., 26 June 1959, *J. Jackson 130* (SRSC); ca. 16 mi. s. e. of Marathon, 13 July 1964, *A. M. Powell & B. Calvert 1252* (SRSC); Tronto Pass, ca. 3 mi. w. of Alpine, 3 June 1965, *Powell & S. Sikes 1320* (SRSC); 17 mi. s. of Marathon, 31 May 1966, *Powell, T. Watson, & Sikes 1408* (SRSC); Hidden Valley near Alpine, 20 June 1941, *R. Rose-Innes & B. Moon*

1261 (TEX); Sunny Glen, 4 mi. w. of Alpine, 4 June 1965, *Sikes 1* (SRSC); 6 mi. n. of Alpine, 5 June 1965, *Sikes 2* (SRSC); 12 mi. s. of Marathon, 4 Sept. 1965, *Sikes 20, 21, 22* (SRSC); n. side of Cathedral Mt., 23 Sept. 1965, *Sikes 29* (SRSC); Basin, Chisos Mts., 26 Sept. 1965, *Sikes 31* (SRSC); Doubtful Canyon, 12 mi. s. e. of Alpine, 2 Sept. 1966, *Sikes 93* (SRSC); s. slopes, Cathedral Mt., 21 July 1960, *M. Snowden & R. Rice 374* (SRSC); Paradise Canyon, 22 Sept. 1935, *O. E. Sperry T325* (LL, SRSC, US); Alpine, May, 1932, *T. L. Steiger 1043* (NY); Jackson Ranch, near Alpine, 13 Aug. 1938, *B. H. Warnock T513* (US); Bluff Cave, 6 mi. s. w. of Alpine, 24 June 1940, *Warnock W907* (TEX); 6 mi. n. w. of Alpine, 17 May 1947, *Warnock 5580* (LL, SMU, SRSC, TEX); 16 mi. s. of Marathon, 29 June 1947, *Warnock 6127* (SRSC, TEX); Doubtful Canyon, 25 mi. s. of Alpine, 18 Sept. 1947, *Warnock & Hinckley 7527* (SRSC); Doubtful Canyon, 18 Sept. 1947, *Warnock & Hinckley 7535* (SMU, SRSC); Doubtful Canyon, 11 July 1948, *Warnock 7983* (LL, SMU, SRSC); upper Pine Canyon, Chisos Mts. 1 Aug. 1950, *Warnock 9179* (SRSC); base of Bailey Peak, Chisos Mts., 6 Sept. 1950, *Warnock 9593* (SRSC); 18 mi. s. of Marathon, 17 June 1964, *Warnock 20419* (SRSC); 3 mi. w. of Alpine, 15 Sept. 1964, *Warnock 20491* (SRSC); 20 mi. s. e. of Marathon, 29 Sept. 1964, *Warnock 20501* (SRSC); Pena Blanco Springs, 9 Oct. 1964, *Warnock 20548* (SRSC). JEFF DAVIS CO: 10 mi. n. of Alpine, near Mitre Peak, 5 June 1965, *Sikes 4b* (SRSC). PRESIDIO CO: e. slope, Goat Mt., 1 Sept. 1959, *L. Campsey 315* (SRSC); e. slope, Goat Mt., 22 Aug. 1959, *Campsey 1060* (SRSC); below San Estaban Lake, 12 mi. s. of Marfa, 18 Aug. 1940, *Hinckley 1296* (LL, NY); Alamito Creek, below San Estaban Lake, 26 June 1964, *Powell 1237* (SRSC); bluffs, s. w. edge of Marfa Flats, ca. 13 mi. s. of Marfa, 26 June 1964, *Powell 1238* (SRSC); n. w. side of Goat Mt., 23 Sept. 1965, *Sikes 30* (SRSC); s. side of Goat Mt., 11 June 1966, *Sikes 48* (SRSC); San Estaban Canyon, 28 May 1957, *Warnock & W. D. McBride 14487* (LL, SRSC); below San Estaban Lake, 24 June 1964, *Warnock 20411* (SRSC); Goat Mt., 5 Aug. 1941, *Warnock 21338* (SMU, TEX).

Perityle rupestris shares its closest relationship with *P. quinqueflora*. This subject is discussed further in connection with the latter species. The primary distinguishing features of *P. rupestris* var. *rupestris* include (7) 8-12 flowered heads, and serrate-lobed leaves which are pilose to hirsute. *Perityle rupestris* var. *albiflora* is readily delimited by its white flowers.

As a relatively wide-ranging species *P. rupestris* is one of the most variable in the genus, being comprised of many populational and cytological entities. In distribution the species extends from the north edge of the Davis Mts. south

to the Chisos Mts. in Brewster Co., and eastern Presidio Co. Practically every disjunct mountain segment in this general area (those with rock bluffs) serves as the habitat for a population of *P. rupestris* which is different either in ploidy level or a few morphic features. However, geographically and morphologically only two varieties seem worthy of recognition. No mixed populations of yellow and white-flowered plants have been found on either side of the imaginary line seen in Figure 19. One small sympatric colony of predominately white-flowered plants was discovered in an intermediate locality which is denoted in Figure 19 along the separatory imaginary line.

At least three other populations of *Perityle rupestris* are reasonably distinct morphologically, cytologically, and geographically, but at the present, it seems that the differences are not sufficient to allow for formal recognition. Locations of the three populations are noted in Figure 19, and examples of each are as follows:

1) *Sikes 45*, Jeff Davis Co., n. slopes of Timber Mt. above Madera Springs; flowers yellow, large heads, large, subreniform leaves, chromosome number, n = ca. 34.
2) *Powell 1408*, Brewster Co., 17 mi. s. of Marathon; flowers white, restricted to Caballos Novaculite exposures in the Marathon Basin, chromosome number, $n = 17$.
3) *Powell 1237*, Presidio Co., 9 mi. s. of Marfa, below San Estaban Dam; flowers white, leaves large, chromosome number, $n = 34$.

Several other polyploid populations of both yellow and white-flowered varieties have been discovered (Table I), but these do not deviate notably from the typical morphology of their respective varieties. Many individual plants of most populations have been checked for their chromosome number, and the ploidy level has been shown to be consistent in each population, or at least in each cluster of plants examined. However, two qualified exceptions to the latter condition have been detected. In Madera Canyon of Jeff Davis Co., tetraploids ($n = 34$) and diploids ($n = 17$)

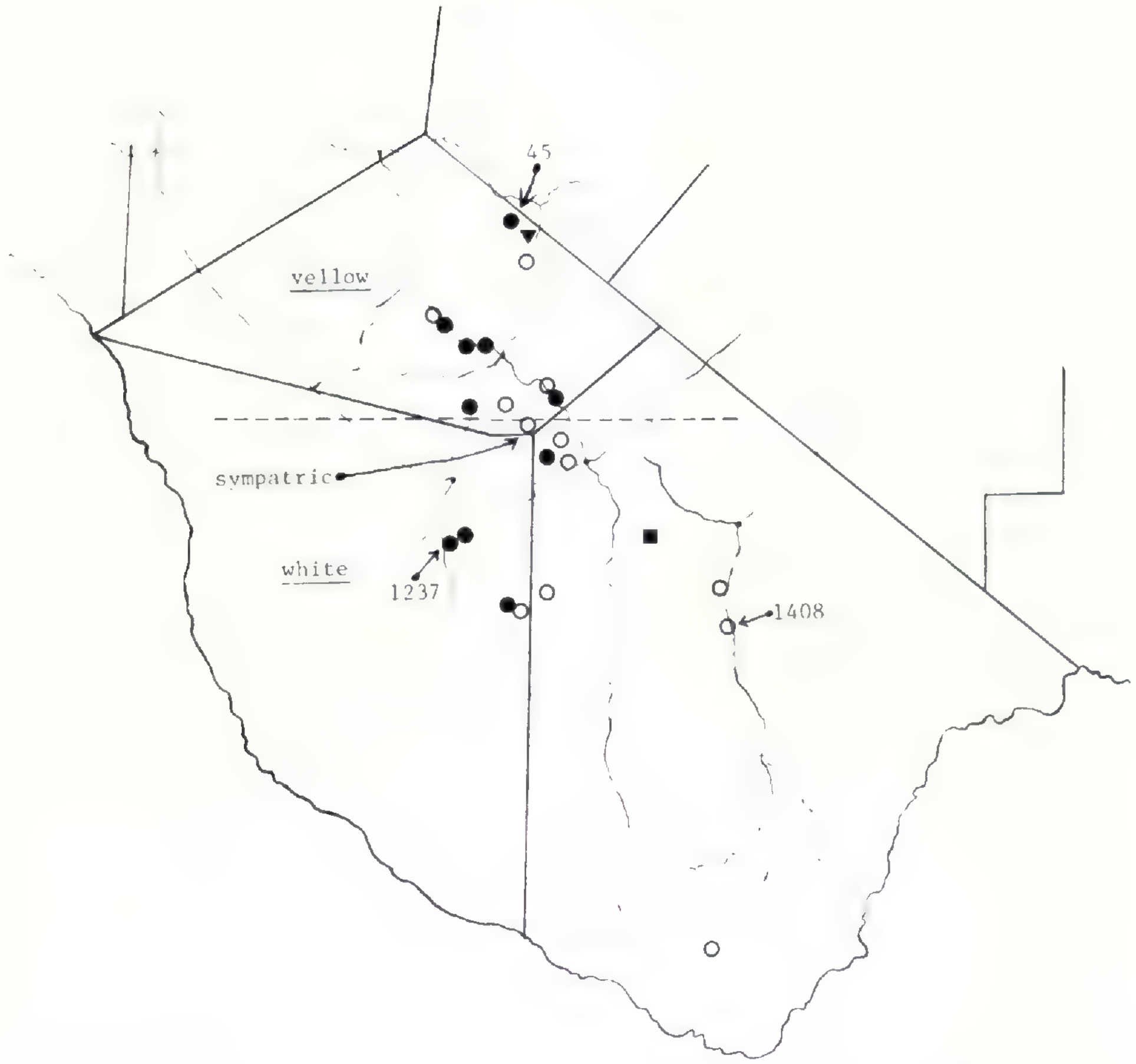

Figure 19. Distribution of diploid and polyploid populations of *Perityle rupestris:* Open circles ($n = 17$); closed circles ($n = 34$); triangle ($n = 68$); and square ($n = 85$). The broken line designates a uniform disjunction of yellow-flowered populations (*P. rupestris* var. *rupestris*) to the north and white-flowered populations (*P. rupestris* var. *albiflora)* to the south. An arrow points to the intermediate location of a sympatric colony of predominately white-flowered plants. Locations of three populations with cytological and/or slight morphological differences from typical *P. rupestris* are denoted by voucher collection numbers and arrows.

were collected about 20 feet apart. On Goat Mountain in Presidio Co., tetraploids were collected on the northwest side and diploids on the south side, and it is likely that plants with both ploidy levels are mixed at some point along the west side of the mountain.

There seems to be no pattern for the evolution of polyploid populations of *P. rupestris* (Fig. 19). It is clear, however,

that once polyploids become established they are successful, even to the exclusion of diploids or other ploidy levels.

No direct evidence has been accrued to elucidate the origin of polypoids in *P. rupestris*. The similar morphology of diploids and polyploids seems to justify speculation that all the polyploids in this species have arisen through autoploidy or perhaps segmental alloploidy in the sense of Stebbins (1950). There is no indication that other species of section *Pappothrix* have contributed to an alloploid origin of any polyploid populations of *P. rupestris* even though preliminary interspecific hybridization experiments (Powell, 1968a) with diploid species have shown that there is no stringent reproductive isolation between species.

Reasonable conjecture would lead one to believe that populational isolation of a wide-spread *P. rupestris* began with the erosion of semi-continuous mountain systems in the Trans-Pecos region of Texas. A cursory examination of the present discontinuous topography and ecology (mainly habitat in crevices of rocks) in the Trans-Pecos indicates that interspecific and even large-scale interpopulational outcrossing of *P. rupestris* populations was probably precluded. This is substantiated by both the allopatric distribution of the extant species of section *Pappothrix*, and in particular by the allopatry of the various different populations of *P. rupestris*.

The anomalous populations of *P. rupestris* are being studied chromatographically, with some interesting results (Powell and Tsang, 1966). A comprehensive systematic study of this diploid and polyploid complex is in progress.

4. **Perityle vitreomontana** Warnock, Southw. Nat. **12** (4): 475-476. 1967.

TYPE: TEXAS: BREWSTER Co: limestone bluffs, w. slopes of Old Blue, Glass Mountains, ca. 4500 ft., 22 Sept. 1963, *B. H. Warnock and A. M. Powell 19111* (Holotype, SRSC! Isotype, TEX!).

Plants 3-10 cm high, pilose, densely leafy; leaves opposite, becoming alternate above, 0.7-1.0 (1.3) cm long, 0.5-0.8 (1.2) cm wide, ovate to ovate-deltoid, the margins obtuse-serrate to incised-lobed, rarely laciniate, typically obtuse, rarely subacute at the apex, sub-

truncate to subacute at the base, pilose, strongly veined; petioles 2-4 mm long; inflorescence typically of loosely clustered heads, rarely solitary, borne on short peduncles, (0.1) 0.2-0.3 (0.8) cm long; heads narrowly campanulate, 6-7 mm long, 3-4 mm wide, often mostly obscured by leaves; receptacle essentially flattened to slightly convex, 1-2 mm wide; bracts (9) 10-12, 4-5 mm long, 0.8-1.0 mm wide, obscurely keeled; disc flowers 11-16; disc corollas white, 4.2-4.5 mm long, the tube 0.8-1.0 mm long, minutely glandular-pubescent, the throat tubular, ca 2.5 mm long, sparsely glandular-pubescent, the lobes narrow, acute, reflexed, 0.8-1.0 mm long; achenes 1.9-2.0 mm long, flattened, typically truncate at base and apex; pappus typically of 2-(3) very slender bristles, 1.2-2.0 mm long, often with 3-6 bristles, most shorter than the main 2, rarely with 10-20 short to vestigial bristles and nubs, the bristles minutely antrorse-ciliate; anthers ca. 2.0 mm long; chromosome number, $n = 17$.

A rare edemic found only on limestone bluffs in the Glass Mountains, north and north-west side, eastern Brewster County (Fig. 17).

Representative Specimens:

TEXAS: BREWSTER CO: limestone bluffs, n. side, Glass Mts., *S. Sikes 110* (SRSC); on Baldy Peak, Glass Mts., 13 July 1940, *B. H. Warnock W247* (SRSC, TEX, UC); w. slopes of Gilliland Peak, Glass Mts., 5400 ft., 29 Aug. 1947, *B. H. Warnock 6953* (SRSC); w. slopes of Old Blue, Glass Mts., 4700 ft., 27 July 1957, *Warnock and W. D. McBride 15663* (LL, SRSC); near top of Old Blue, Glass Mts., 6500 ft., 15 Aug. 1962, *Warnock 20405* (SRSC); Old Blue, Glass Mts., 5000 ft., 18 June 1964, *Warnock 20412* (SRSC).

This remarkable species exhibits a superficial relationship with *Perityle bisetosa*. The small habit, white-flowered discoid heads, and 2 main pappus bristles of *P. vitreomontana* are features which resemble those of *P. bisetosa*. However, leaf and flower morphology indicate a close affinity of *P. vitreomontana* with *P. rupestris* var. *albiflora*, and a close study of the pappus of *P. vitreomontana* shows a structure which is reduced and derived from the section *Pappothrix* type. Characteristically there are 2 or 3 prominent bristles of the pappus, but in each case vestigial nubs are present between the main ones. By examination of several individuals, and often in different florets of the same head, one may observe a larger number of prominent bristles, 4-10, and rarely even 10-20. Vestigial nubs are almost always present when less than 10-15 rather well-

formed bristles predominate. *Perityle vitreomontana* is regarded, therefore, as belonging with the section *Pappothrix*, a disposition also supported by general morphology and chromatographic data (Fig. 9; Powell & Tsang, 1966).

5. **Perityle cinerea** (A. Gray) Powell, sida **3**: 278. 1968. Fig. 20.
Laphamia cinerea A. Gray in Torr., Bot. Mex. Bound. 82. 1859. TYPE: TEXAS: on rocks near Escondido Creek, Sept., *Bigelow s. n.* (Holotype, GH! Isotypes, NY! US! Photograph, DS!).
Pappothrix cinerea (A. Gray) Rydb., N. Amer. Fl. **34**: 27. 1914.

Plants 8-25 (45) cm high, tomentose-canescent, densely leafy; leaves opposite below, alternate above, 1.2-2.5 cm long, 0.9-1.8 cm wide, broadly ovate to subdeltoid, rarely subreniform, the margins deeply serrate with lobelets obtuse to acute, obtuse to acute at the apex, subtruncate to subacute at the base, tomentose-canescent, but veins still conspicuous; petioles 0.6-1.0 cm long; inflorescence of solitary heads or clusters of heads borne on rather stout peduncles, 0.3-1.0 cm long; heads narrowly campanulate, 0.8-1.0 cm long, 4-7 mm wide, sometimes partially obscured by subtending leaves; receptacle flattened, 1.5-2.0 mm wide; bracts 8-10, 5-7 mm long, 1.1-2.0 mm wide, keeled to obscurely so, tomentose, inner series essentially like the outer except more membranous along the margins and less pubescent; disc florets 10-15; disc corollas white, 5.3-6.0 mm long, the tube 1.3-1.6 mm long, minutely glandular-pubescent, the throat tubular, 2.8-3.2 mm long, sparsely glandular-pubescent, the lobes narrow, acute, reflexed, 0.8-1.2 mm long; achenes 2.6-3.0 (3.5) mm long, partially flattened; pappus of 14-20 slender bristles, the bristles unequal in length, but most are subequal, minutely antrorse-ciliate; anthers (2.3)2.5-3.0 mm long; chromosome number, n = ca. 68.

Rare in crevices of Cretaceous limestone caprock of mesas. Spring-Fall (Fig. 17).

Representative Specimens:

TEXAS: PECOS CO: on rocks near Escondido Creek, Sept., *Bigelow s. n.* (GH, NY, US); 6 mi. e. of Bakersfield, April, *M. McKenzie 128* (SRSC); 7-Mile Mesa, near Ft. Stockton, 15 Sept. 1964, *A. M. Powell 1310* (SRSC); cracks in caprock, 17 July 1943, *B. C. Tharp 43-965* (TEX, US); limestone caprock and on top of mesa, 1 July 1943, *Tharp 43-966* (ND, POM, RM, SRSC, TEX, US); 7-Mile Mesa e. of Ft. Stockton, 16 Aug. 1962, *Warnock 20403* (SRSC); Ft. Stockton, 14 June 1907, *H. H. York 291* (DS, SRSC, TEX). UPTON CO: ca. 10 mi. s. of Rankin, Noltke Hill, 14 Sept. 1961, *Correll & Johnston 24607* (LL).

Plants of this species are strikingly cinereous. Individuals of a single population may be suffruticose and rather tall

Figure 20. Habit sketch of *Perityle cinerea (Powell 1310)*; × 1.

or very short and appressed to rocks, at least in some instances depending on whether or not they are in reach of sheep which browse the plants. *Perityle cinerea* appears to be most closely related to *P. vitreomontana* or the white-flowered variety of *P. rupestris*, notwithstanding the tomentose-canescent pubescence which is not approached by any other species of the genus except the Guadalupe Island endemic, *P. incana*.

The type locality of Escondido Creek, now called Tunis Creek, is about 30 miles east of Fort Stockton. No plants of this species could be found in the small rock bluffs along

the creek, and this is not a typical habitat for *P. cinerea*. Therefore, it appears that the original collection was made somewhat near there but higher up on the mesas which abound in the area along the route taken by Bigelow's party.

The distribution of *Perityle cinerea* overlaps that of *P. angustifolia* (sect. *Laphamia*) along the Cretaceous caprock exposures in eastern Pecos Co. Plants of these two species have been observed growing side-by-side (but not extensively intermixed) about 6 miles east of Bakersfield. No interspecific hybridization has been detected, but fertile progeny would be unlikely since the chromosome number of *P. cinerea* is n = ca. 68 as compared to n = 17 for *P. angustifolia*.

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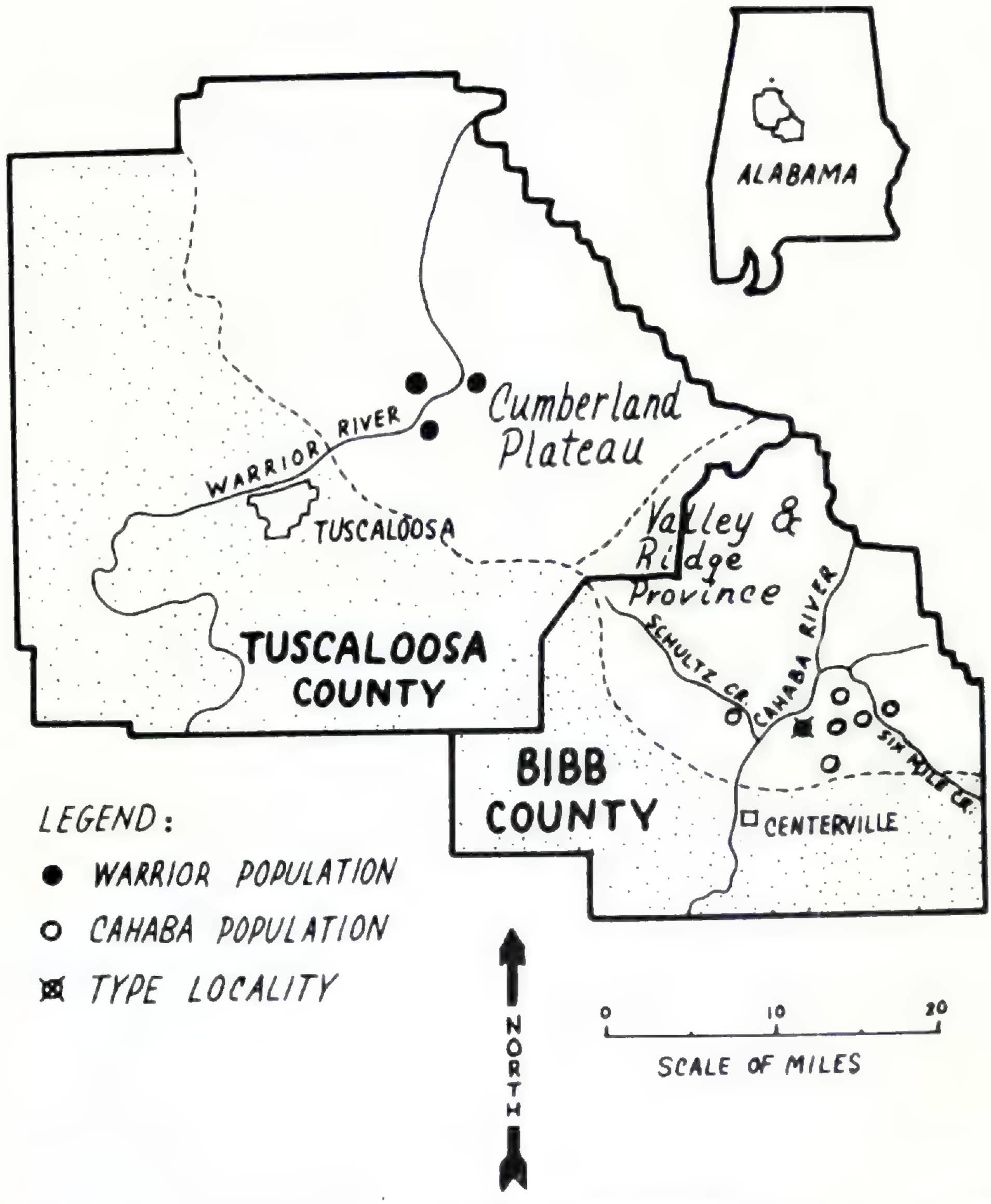
DISJUNCTION AND ENDEMISM IN CROTON ALABAMENSIS

JOE A. FARMER AND JOAB L. THOMAS

Croton alabamensis E. A. Smith *ex* Chapman is one of the rarest shrubs in the United States. It is known from two river valleys in central Alabama and is very narrowly distributed within this area (Map I). In the Herbarium of the University of North Carolina there is one sheet of *Croton alabamensis* which is reported from Tennessee. The label data on this sheet is as follows: Tullahoma, Coffee County, Tennessee, *T. G. Harbison 725*, Aug. 10, 1899. There is no other known record of this species outside of Alabama, and due to the very distinctive appearance of the plant at all seasons of the year it is unlikely that this species occurs in Tennessee at the present time. However, anyone doing field work in the vicinity of Coffee County should certainly be on the lookout for this rare plant. The species was first discovered in 1877 by Eugene A. Smith along the Cahaba River in Bibb County, Alabama. In 1905 Dr. Roland Harper found it along the Warrior River in Tuscaloosa County. Since that time the known range has been extended very little (Farmer, 1962). The species is now known from ten sites occupying something less than 100 acres irregularly distributed over about 30 square miles; about 25 square miles in the Cahaba River drainage, and about 5 square miles in the Warrior River drainage. Within these limited areas the species forms dense thickets giving the superficial appearance of one or more large clones, but no evidence of asexual reproduction of any kind has been found in this species.

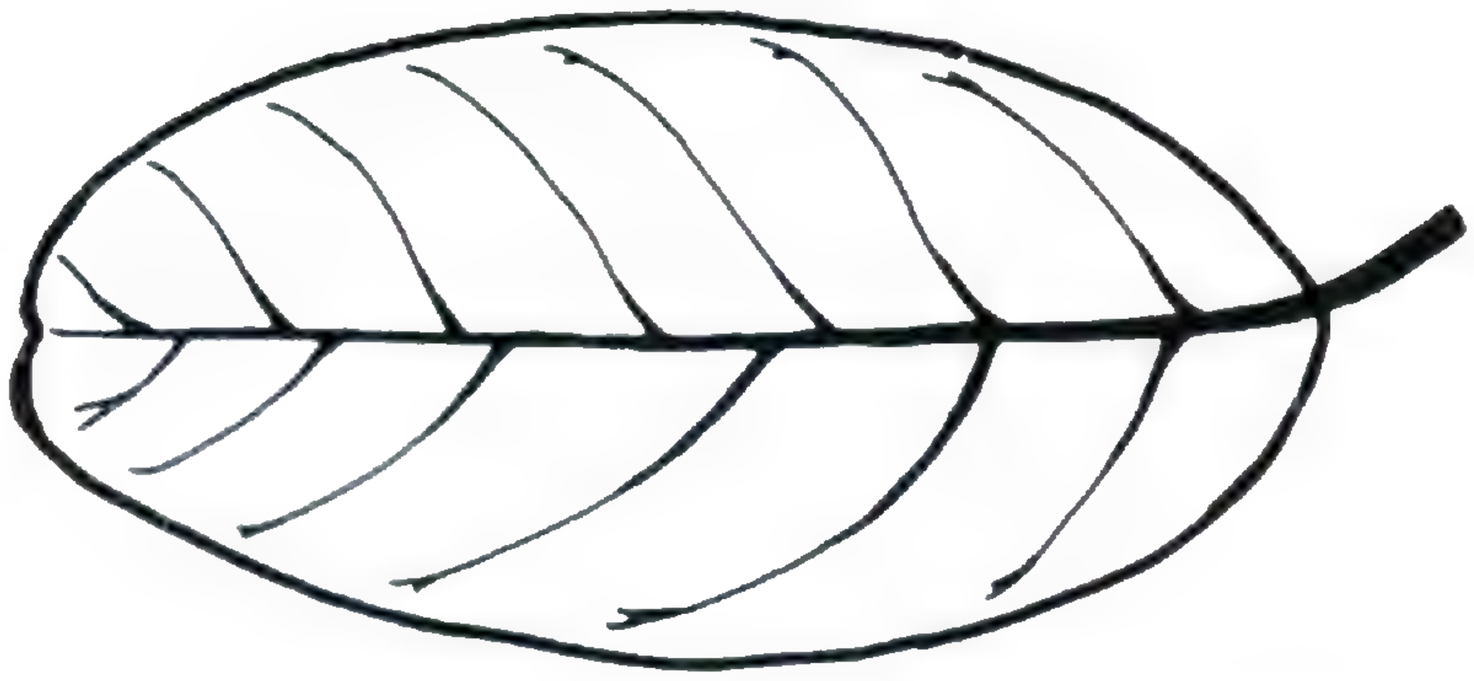
The distance between *Croton* sites on the Warrior and the nearest site on the Cahaba is approximately 25 air miles. This distance is apparently sufficient to prevent gene exchange between the populations in the two areas even in this wind pollinated species. Thus *Croton alabamensis* is particularly unusual in that it combines narrow endemism with



Map I. The distribution of *Croton alabamensis*. The stippled area represents Coastal Plain. Note that the distribution of this species is near, but always above, the Fall Line shown in dashes.

a disjunct distribution. In addition there is an interesting variation pattern both within and between the disjunct populations. The Warrior population differs from the Cahaba population in several morphological characteristics, and there is some evidence that they differ physiologically as well.

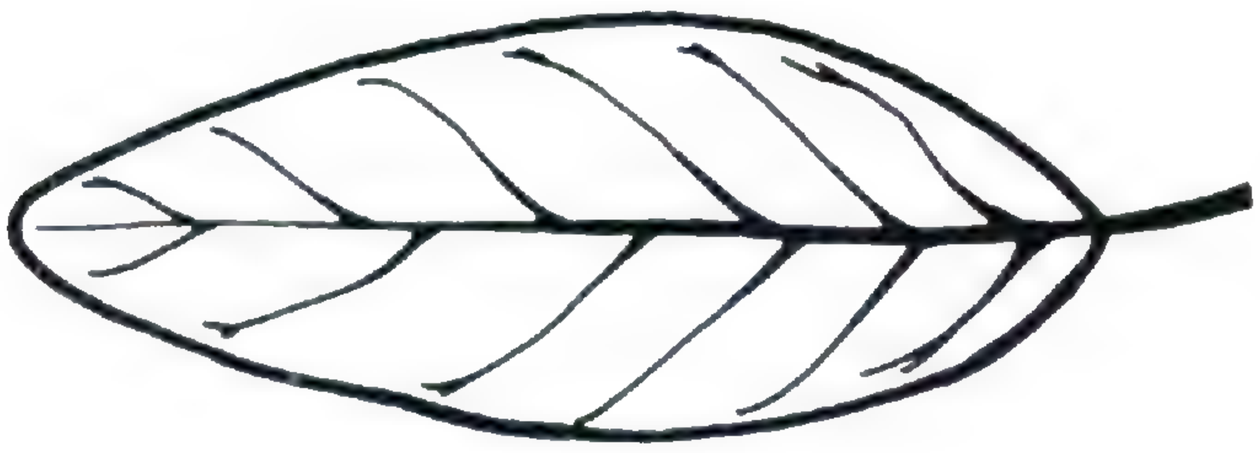
A.



TYPICAL LEAF OF WARRIOR POPULATION

1. Elliptical form
2. Emarginate apex
3. Average size: 37 ± 9.5 (50) mm by 80 ± 19.7 (50) mm

B.



TYPICAL LEAF OF CAHABA POPULATION

1. Ovate form
2. Acute apex
3. Average size: 25 ± 7.5 (50) mm by 66 ± 18.9 (50) mm

C.

TYPICAL LEAF OF PLANTS OF THE CAHABA POPULATION CHARACTERIZED BY UNUSUALLY SMALL LEAVES

Average size: 10.4 ± 2.47 (14) by 24.6 ± 7.18 (14) mm

Fig. I. Leaf variation in *Croton alabamensis*.

VARIATION BETWEEN WARRIOR AND CAHABA POPULATIONS

Mature plants of *Croton alabamensis* vary in height from about 1/2 to 3 1/2 m averaging about 1 1/2 m. In the Warrior population the mature shrubs average about 20% taller than those in the Cahaba population. Several differences are apparent in the size and shape of the leaves (Fig. I). The average leaf blade size for Warrior plants is 37 ± 9.5 (50) mm. The largest single leaf found in this population measured 75 by 170 mm. For the Cahaba population the plants can be divided readily into two categories based on leaf size as indicated in Fig. I. Most of the plants are like those indicated by B in Fig. I, where the average size was 25 ± 7.5 (50) mm by 66 ± 18.9 (50) mm; whereas for the fewer, extremely small-leaved plants, (Fig. I C) the average leaf size was found to be only 10.4 ± 2.47 (14) mm by 24.6 ± 7.18 (14) mm. Leaf shape in the Warrior plants also differs consistently from that of Cahaba plants. Leaves of Warrior plants are elliptical with an apex which varies from slightly to distinctly emarginate; those from Cahaba plants are more ovate with an acute apex which is not emarginate.

Reproductive structures also show a consistent size difference between plants from the two river valleys. Flowers, fruits and seeds from Warrior plants are approximately 20% larger than those from Cahaba plants. It was also observed that in the Cahaba population relatively more branches bear predominantly pistillate inflorescences, as compared with approximately equal numbers of staminate and pistillate inflorescences found on Warrior plants. Normal time of first flowering for the species is within the first two weeks of March, but Cahaba flowering usually precedes Warrior flowering by about a week. Erratic occurrence of a few flowers at almost any time of year is not uncommon but was observed to occur with greater frequency among Cahaba plants.

CYTOLOGY

Previously it was thought that the plants from these two river valleys differed in chromosome number, the Warrior

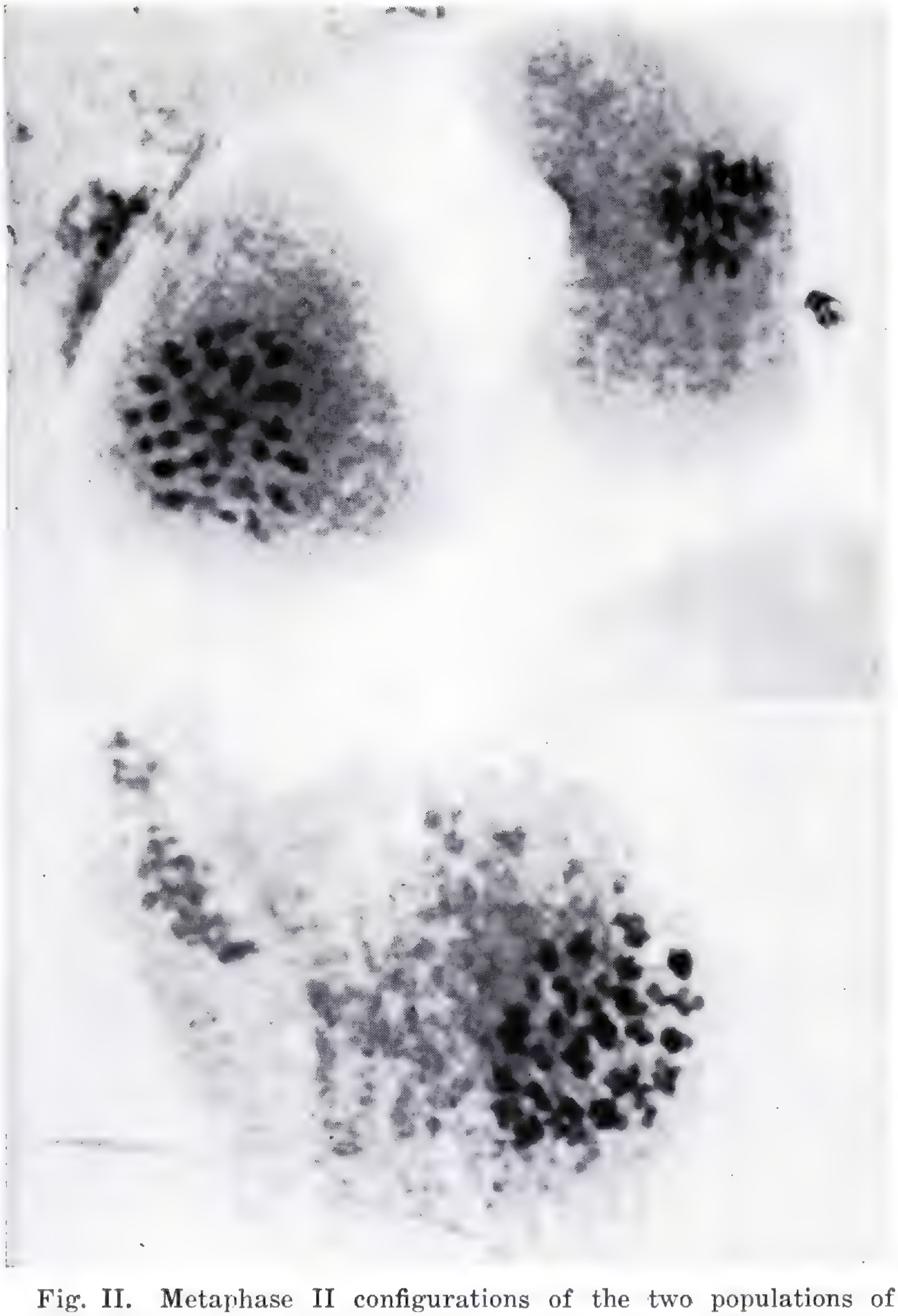


Fig. II. Metaphase II configurations of the two populations of *Croton alabamensis*. Above, Cahaba population; below, Warrior population.

material having $n = 32$, the Cahaba material $n = 16$. (Farmer 1962, Webster 1967). This correlated very nicely with the size differences noted above. Recent studies have shown that the situation is not that simple. During February and March 1968, chromosome counts were made on 15 different individuals from the Warrior population, and 18 different individuals from three different sites in the Cahaba drainage. The latter included individuals representing most of the morphological variation described above. All of the individuals examined from both populations were found to have the number $n = 32$. This is not to imply that the original counts were in error, although no 16-chromosome plants were found in this survey of 33 individuals from four different sites. The authors are convinced that at least the Cahaba populations contain individuals with the number $n = 16$ as well as individuals with $n = 32$, although the latter number apparently occurs with much greater frequency. The lower chromosome number previously reported for Cahaba material was seen in both mitotic and meiotic divisions. The mitotic counts were made on radicles of germinating seeds, the meiotic counts on pollen mother cells. The counts made during the spring of 1968 were primarily on pollen mother cells, although one count from each river system was made on root tips of softwood cuttings. Voucher specimens of three individuals from each population counted are deposited in the herbarium of the University of Alabama. For the Cahaba population the voucher specimens are *Joab L. Thomas #1615, 1616, 1617*; for the Warrior population, *Joab L. Thomas #1628, 1629, 1630.*

Meiosis appeared to be normal in all of the material examined. Diakinesis was rarely seen in this material, but when this stage was encountered bivalent pairing was evident and no clear multivalent formations were seen. The chromosomes of *Croton alabamensis* are very small, and there is considerable size variation within the chromosome complement. Correlated with a difference in flower size noted between Warrior and Cahaba material, bud size and

anther size at the time of meiosis is approximately 20% larger in Warrior material than in Cahaba material. For this reason, and perhaps for others, Warrior material was much easier to work with, and it was always easier to find division figures in this material.

An interesting relationship was noted between division synchrony and weather conditions at the time the material was collected. Generally, in material collected during an unusually cold period a high degree of asynchrony was seen, whereas material collected a day or two following a short warm period would invariably show more synchrony.

HABITAT

A brief description of the habitat of *Croton alabamensis* is particularly interesting and relevent because an equally rare species, *Neviusia alabamensis* has recently been found growing along side the *Croton* in one small area along the Warrior River. The habitat consists of moderately-to-steeply-sloping terrain with shallow soil derived from and underlain by sandstone, shale, or limestone. The area is also characterized by high soil and air temperature and intense drought during the summer. During late summer, in particular, extreme drought is a common feature of the rock-outcrop habitat. The relief of the Warrior and Cahaba areas is similar. Elevations range mostly from 300 to 400 feet above sea level. The *Croton* thickets in the Cahaba drainage are mostly on gentle slopes of approximately 20 degrees and are usually facing south or southwest. Those of the Warrior area are found primarily on north-facing bluffs where the slopes are estimated at greater than 45 degrees (Fig. III). The difference in exposure is thought to be primarily responsible for the generally higher soil and air temperatures recorded in the Cahaba habitat. Also, in spite of the steep slope, the Warrior habitat usually has more soil moisture due to seepage through the shale. In both areas the thickets are usually found about midway up the slopes, seldom extending either to the top or to the base of the slopes.

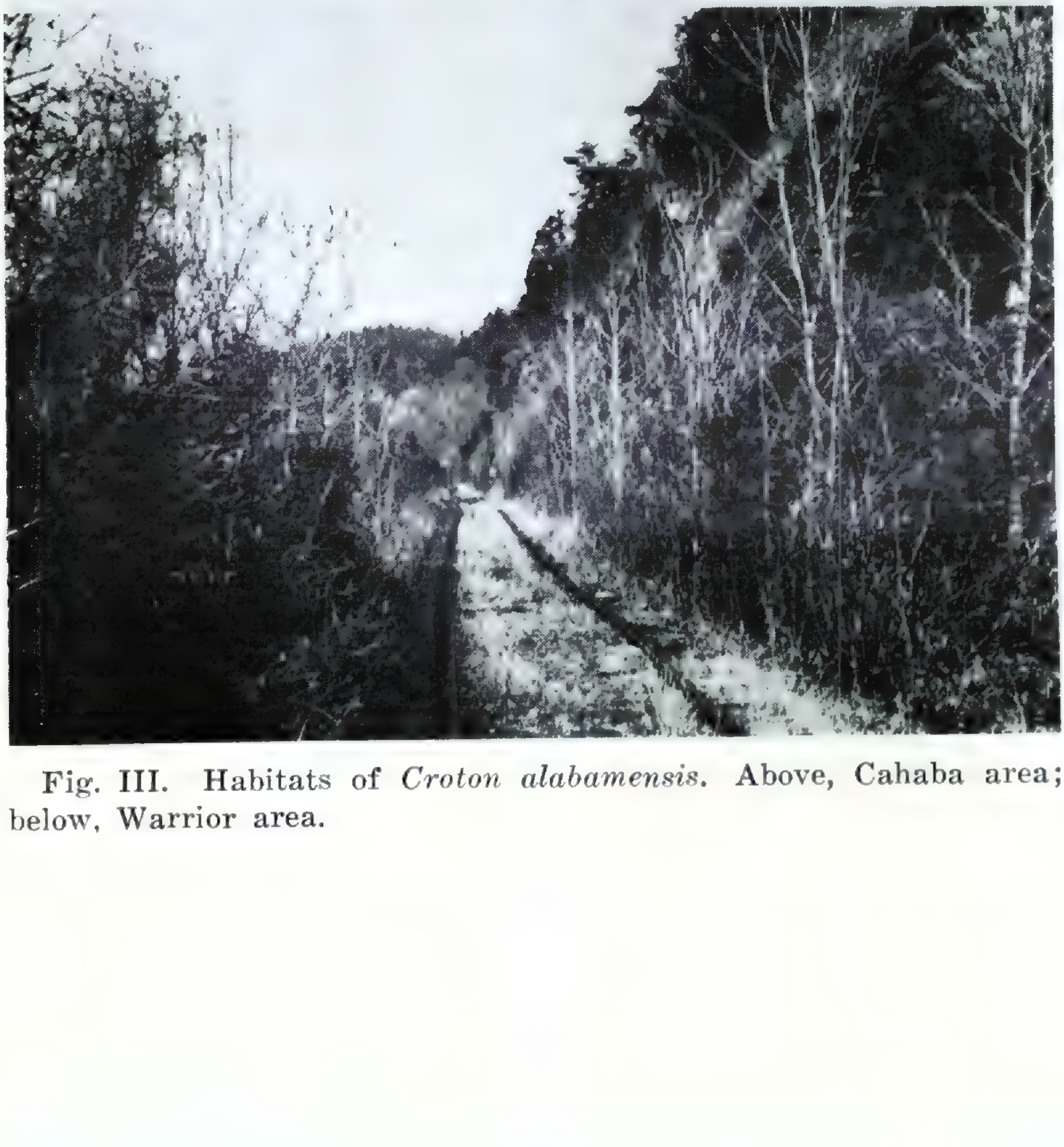


Fig. III. Habitats of *Croton alabamensis*. Above, Cahaba area; below, Warrior area.

Prominent outcrops of bare rock are visible throughout the area of both the Warrior and the Cahaba populations, but the rocks are of different geological ages and mineral composition in the two areas. The rocks of the Warrior area are primarily Pottsville shale and sandstone of the Pennsylvanian, whereas those of the Cahaba are mostly Ordovician limestone. Likewise soil pH shows some variation between the two areas, that of the Cahaba ranging from 6.5 to 7.8, that of the Warrior from 6.0 to 6.8.

Morphological and physiological characteristics of *Croton alabamensis* which apparently contribute to its survival in this habitat include the following. Flower buds develop and become well differentiated in late spring and are dormant before the beginning of summer extremes of drought and high temperature. The following spring the pre-formed buds flower and develop fruits rapidly, seed dehiscence usually being complete by the end of May. Heavy seed crops are produced each year, and the seeds are released by a catapult mechanism with adequate range to seed most of the available substratum. This is thought to be an important factor in maintaining the locally dense populations of *Croton*. Because of dormancy the seeds do not germinate until early the following spring. Young seedlings rapidly become established and enter dormancy early in the summer. In this manner the seeds and the seedlings survive the drought and high temperatures of late summer. Adaptations favoring moisture conservation within the plant during these extremes include: (1) stomata on the lower leaf surface only; with the stomata, both leaf surfaces, and the stems densely covered by scale-like, peltate trichomes; (2) drooping or wilted leaves during most of the daylight hours; (3) abscission of many of the leaves during late summer; and (4) general plant dormancy from mid-summer to early spring. The shallow rooting habit is correlated with shallow-habitat-soil and facilitates rapid water absorption following rains.

Thus the habitat factors which are apparently most critical in determining the distribution of this species are

the slope, the shallow soil over rock, and the high soil and air temperatures associated with middle and late summer drought. *Croton alabamensis* seems to be particularly well adapted to this apparently unfavorable habitat.

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LITERATURE CITED

FARMER, JOE A. 1962. An Ecological Life History of *Croton alabamensis* E. A. Smith ex Chapman. Unpublished Ph.D. Thesis, University of Alabama.

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A DEFINITIVE NEW BOOK ON THE FLORA OF NORTHWESTERN NORTH AMERICA[1]

From the rich experience of many weeks and months in the field working closely with the plants he has written about, coupled with thousands of hours of study in herbaria and libraries in many parts of the world, Dr. Eric Hultén has drawn the material presented in a Flora of Alaska and Neighboring Territories. This is a superb book in every respect. Without question, it will be the standard and authoritative reference concerning plants of the region it covers for many years to come. That region includes, besides Alaska, the Chukchi (Chukotka) Peninsula in northeastern Siberia, the Yukon, extreme northwestern British Columbia and the Mackenzie District of the Northwest Territories, Canada.

A distinctive feature of this book is the fact that each species or infraspecific taxon is individually illustrated and maps of its range within the area covered and of its total geographical range are given. The line drawings of each ultimate taxon were prepared by the well-known botanical artist Mrs. Dagny Tande-Lid. These are botanically accurate and artistically pleasing. There are eight full pages of color including forty-nine photographs, all of excellent quality. These are in one section near the middle of the book. They show dramatically some of the varied environments available to plants in the area and some of the more spectacular and interesting plants of the flora.

Long descriptions of the individual taxa are not a feature of Hultén's book and we view this as a step in the right direction. The short descriptions, illustrations and maps are adequate to fix the identity of each taxon. Keys to the families, genera, species and infraspecific taxa are complete. Some 1,974 taxa belonging to 1,559 species are treated in the work.

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[1]Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants, by Eric Hultén. Stanford University Press, Stanford, Calif. xxii + 1008 pp. illus. $35.

Some very involved taxonomic problems are present in the flora dealt with by Hultén. The species of some genera are largely apomictic and in other genera there is an unusual amount of hybridization. In other instances, such as the genus *Carex* with one hundred and twenty taxa, it is the complexity and great reticulate divergence that makes a satisfactory taxonomic treatment difficult. Thirty-four species of *Draba* are treated and here is one case where this is the only satisfactory taxonomic treatment of the genus for the area. One is impressed again with the enormous number of herbaceous species compared to the woody plants of the flora and with the relatively high proportion of monocotyledons vs. dicotyledons. This, of course, is expected in an arctic and subarctic region. But there are large numbers of species in some genera that are rather unexpected. For example, twenty-two taxa of *Pedicularis* seem somewhat unreal when considered from the viewpoint of representation in the rest of North America.

Eric Hultén has studied the plants of the North circumpolar region assiduously and with perseverance for nearly fifty years. He began with an expedition to the Kamchatka Peninsula in 1920. Later he made numerous collections in the Aleutian Islands and the islands of the Bering Straits. His field work included extended periods along coastal Alaska, in the interior of that State and throughout northwestern Canada as well as along the Arctic shores of both Canada and Alaska. In fact, his field research has continued down through the last few years right to the present, in spite of his retirement status.

I remember and still appreciate the wonderful stories Hultén told of his experiences in the unexplored part of Kamchatka, not the least of which were those concerning his unintentional involvement in the dying phases of the Communist Revolution then in progress in southern Kamchatka. With other graduate students in the 1930's, we were privileged to hear accounts of his botanical exploits in the Aleutian Islands and in Northwest America. At the time, he was at the Gray Herbarium studying the collections he had brought back from these remote places.

In building toward the book under review, which in a way is a culminating presentation of a major aspect of the basic findings of a lifetime. Dr. Hultén has proceeded in a very deliberate and resourceful way. His early publication on the Flora of Kamchatka was followed by a book on the Flora of the Aleutian Islands. Then followed an "Outline of the History of Arctic and Boreal Biota during the Quaternary Period". A major contribution was his "Flora of Alaska and Yukon" published between 1941 and 1950. The Amphi-Atlantic Plants and their Phytogeographical Connections, published in 1958, treated many arctic or subarctic taxa pertinent to the present work and the relevance of the more recent "Circumpolar Plants" is at once apparent. All of these were major contributions and show in a very positive way the full depth of the author's background for writing the book at hand.

The volume is excellently produced with a good quality of paper and a pleasing format. Although the cost may make it prohibitively expensive for many individuals, libraries and institutions having any interest at all in the plant cover of a large segment of North America cannot afford to be without this highly significant book.

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A NEW WILDFLOWER GUIDE

Field Guide to Wildflowers of Northeastern and North Central North America. Roger Tory Peterson and Margaret McKenny. Houghton Mifflin, 1968. $4.95

In the past decade there has been an increasing interest by the public in the identification of wild flowers, with consequent demand for a useful popular guide. Several successful bird guides have been published and it has seemed that the format of these could be imitated to produce a useful flower guide. The problem has turned out to be difficult. A standard bird guide lists all species east of the Rockies in about 300 pages. For a guide to be successful, financially, the publishers demand that as large a territory as possible be covered. The standard now seems to be the United States west to the Dakotas and south to North Carolina. This guide in addition includes parts of Ontario and Quebec. Even excluding grasses, sedges and other such plants, there are very many species in a territory of this size and most guides omit many, including some quite common ones. Thus Wherry includes 500 species with 428 illustrations. Peterson includes almost 1300 species with 1344 illustrations, which mean that anyone trying to identify a flower, especially in the northeastern part of the country, probably will find it listed in the guide. To achieve this admirable coverage in a pocket size guide, the descriptions are necessarily brief. Included are range, habitat, size and one or two key points. Those wishing a more complete description should refer to a more detailed guide.

As stated in the introduction, the book is designed for those people who are unable to use keys, but belong to the picture-matching school, which is the average amateur's approach to plant identification, and, except for checking the range, is about as far as most will go. The system is based on (1) color, (2) general shape or structure, (3) distinctions between similar species. For this last purpose only a leaf of the plant may be shown as in the case of some of the blue violets. Color is the basic approach, and to adhere to it the traditional procedure of arrangements

by families is abandoned. Thus the first part of the book consists of white flowers. Here for example are found all white orchids in one section, the wide-leaved orchids on one page, the spurred orchids on the next and the showy on the third. *Cypripedium acaule* appears here and also in the pink section of the book. In various other cases where there may be color confusion, flowers are listed twice. The color sections after white, are yellow, pink to red, violet to blue, orange, green and brown. Clearly in some cases a user would have to check 2 different color sections to locate a plant. All but a few of the plants are illustrated but many of the illustrations are line drawings with the color indicated at the top of the page and in the text. No doubt many users would prefer color for all illustrations, which, however, would presumably make the book much more expensive.

The procedure of having one family spread through several sections of the book seems strange at first sight. In practice, however, it is quite workable. A user, aware he had a Legume, would refer to the front of the book where there is a brief description of the Pea Family and page listings for the various colors which are readily checked. A user with *Desmodium canadense* should locate it without difficulty on the appropriate page and would probably correctly identify it. If he happened to have one of the other 9 Desmodiums listed he might well have one difficulty in making a determination although an effort is made to indicate key points. Of necessity a number of the Desmodiums are omitted but the selection seems to be reasonable. An effort is made to make the user aware of the significance of families. For each species, the family is indicated with a pictogram designed to call attention to a characteristic of the family. For the Legumes a generalized pea-like flower is used. The symbolism is varyingly successful, but the perceptive user is likely to acquire some appreciation of family.

Amateurs demand common names for plants. Many have become standard but in other cases it has been necessary

to supply them. The author has in some cases translated the scientific name and in others has endeavored to devise an appropriate one. It is to be hoped that widely recognized common names will come into general use for flowers as they have for birds and most trees and shrubs.

Some users will not find the color key always satisfactory with plants of intermediate hue being listed under a less familiar shade. The distinctions between closely related species, as in the Violets, are not always workable. These are minor criticisms. The book is excellent and sets new standards for popular guides. It also would be of considerable use to the professional botanist who might be working with unfamiliar groups in new territory.

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CONTRIBUTIONS TO THE MARINE ALGAE OF NEWFOUNDLAND[1, 2]

By

Arthur C. Mathieson, Clinton J. Dawes and
Harold J. Humm

Introduction

Relatively little is known of the benthonic marine algae of Newfoundland. De la Pylaie (1824, 1829) listed several collections from the Island, but as suggested by Taylor (1954) his catalogue is too old to be currently useful. The only recent account of marine algae from Newfoundland is that given by Wilce (1959) who collected at four locations on the northwest and central west coasts. His collections were made while enroute to the Labrador Peninsula. There are so few other published records (see Taylor, 1957 for listings) that the composition of the Newfoundland marine flora has been inferred from collections of the nearby islands of St. Pierre and Miquelon (Le Gallo, 1947, 1949). The present paper summarizes the species found during two trips (1948 and 1967) to Newfoundland. Collections were made from a variety of coastal environments.

During the month of August, 1948, a survey of the distribution and abundance of algae of potential economic value was made by Humm for the Newfoundland Industrial Development Board. A general collection was made and field notes were kept. In July and August, 1967, Dawes and Mathieson made extensive collections and field observations along the coast of Newfoundland. The second trip was conducted in conjunction with a survey of algae of economic importance, and it was sponsored by Marine Colloids Inc.

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[1]Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as scientific contribution number 462.

[2]Contribution No. 37 from the Department of Botany and Bacteriology, University of South Florida.

Procedures

1948: Since only the month of August was available for field work the areas visited were limited to the more populated and accessible localities of the eastern coast, particularly the Avalon and Burin Peninsulas, and to the portion of the north coast from Cape Freels to Gander Bay — including Fogo Island and New World Island (Fig. 1). The portions of the eastern coastline with an accessible road were covered by automobile. Stops were made at each cove, village or coastal area where there was accessible shallow water and where a small boat could be obtained. The coastal areas included the lower part of the Burin Peninsula, the eastern side of Placentia Bay from Argentia to St. Bride's, the eastern side of St. Mary's Bay, Trepassey Bay, the eastern side of the Avalon Peninsula, Conception Bay and the eastern side of Trinity Bay (Fig. 1).

The 38-foot motor vessel Duckhawk was used to visit stations in upper Placentia Bay and the western side of St. Mary's Bay, including many islands in both and the coastline and islands along the eastern portion of the north coast between Cape Freels and Notre Dame Bay. Most of these areas were inaccessible except by boat. Stations were examined and representative collections were made from a dory which was launched from the larger vessel. Station descriptions are given for each location where collections were made. Herbarium voucher specimens from the summer collections of 1948 are in the personal herbarium of H. J. Humm and the Herbarium of Duke University.

1967: The locations visited during 1967 were selected on the basis of previous observations (i.e. the 1948 field notes of H. J. H.) and (or) after examination of hydrographic charts. Most of the locations were shore sites, but a number of offshore islands were studied in Conception Bay by means of a fishing vessel (Fig. 1). A skiff and outboard motor were available for use at all stations. Collections were made at most locations in the littoral zones (on foot) and sublittoral zones (by diving with a snorkel or hooka apparatus). A record of surface water salinity and temperature was

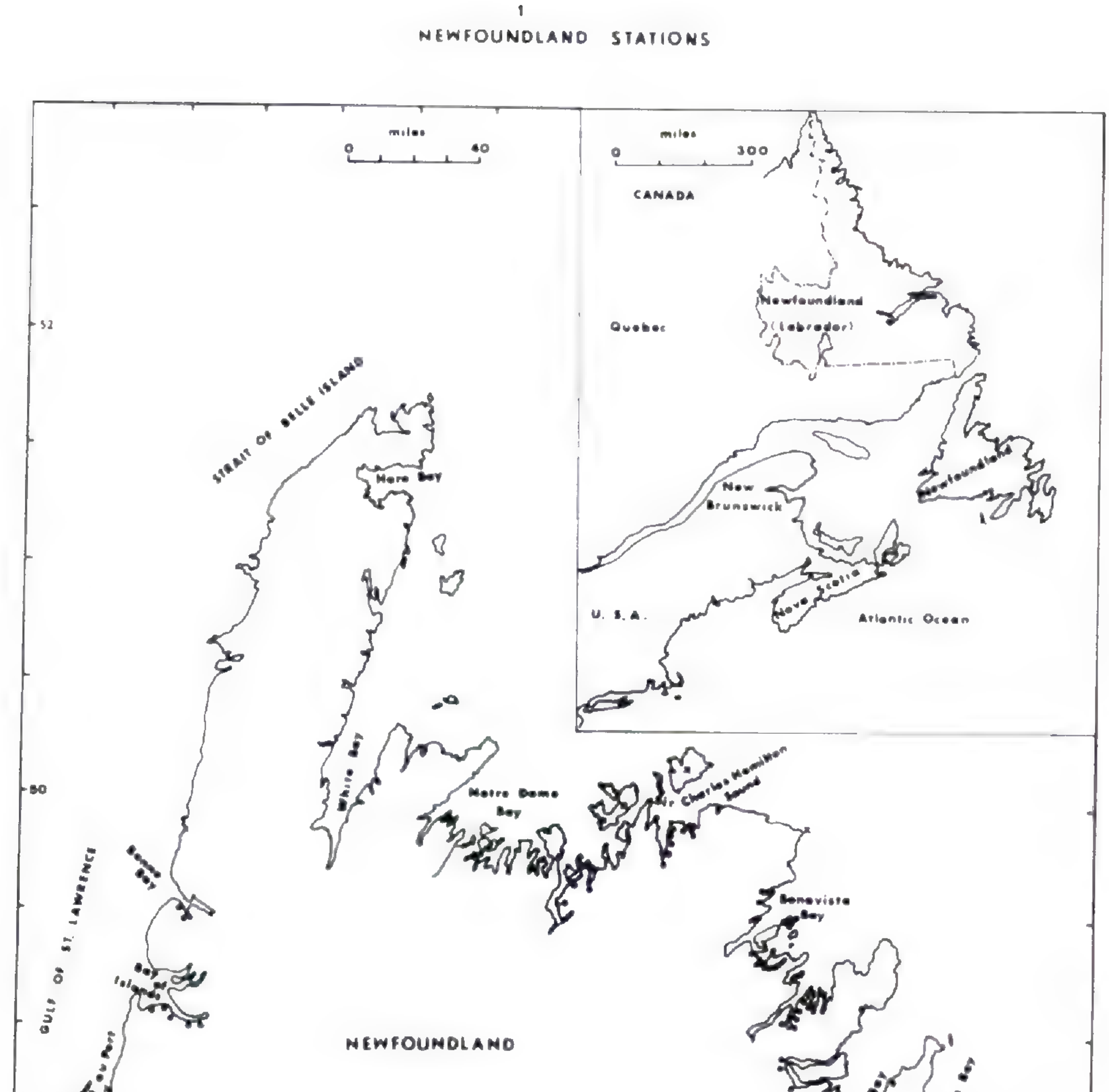

Fig. 1. Map of Newfoundland showing sites of collections.

made at most stations with a thermometer and a set of hydrometers. All of the field data were recorded at the site with a portable tape recorder. Representative collections were made of all the conspicuous species at each station. The collections were preserved (4% formalin) for later identification and preparation of herbarium specimens (about 900 herbarium voucher specimens). All of the 1967 collections from the Southern Shore, Trepassey Bay, St. Mary's Bay, Placentia Bay, and Fortune Bay are deposited in the Herbarium of the University of South Florida, Tampa (see Description of Stations for specific details of locations, dates, etc.); all other 1967 collections are deposited in the Herbarium of the University of New Hampshire, Durham.

A variety of references was consulted for identification of species and determination of presently known distributions along the Atlantic Coast of North America (Adey, 1964, 1965, 1966; Blomquist and Humm, 1946; Bornet and Flahault, 1886-88; Cardinal, 1964, 1965, 1966, 1967a, b, c, d; Collins, 1909; Edelstein and McLachlan, 1966, 1967a, b; Edelstein, McLachlan and Craigie, 1967; Fritsch, 1935, 1945; Gomont, 1892; Humm, in press; MacFarlane and Milligan, 1965; Scagel, 1966; Taylor, 1957; Widdowson, 1964; Wilce, 1959, 1965; Wulff et al. 1968; Zaneveld, 1966). The nomenclature of the recent British Checklist (Parke and Dixon, 1964) has been applied in most cases. The vertical distribution of the major algal components described in this article is according to the biological classification of Lewis (1964).

Description of the Area

Newfoundland, an island of 42,734 square miles and a province of Canada, is located off the East Coast of North America, northeast of the Gulf of St. Lawrence between 47° and 52° north latitude and 52° and 59° west longitude.[3] The coast is rocky (often precipitous) and usually lacks sandy beaches. In general, there is not much shallow water. The

[3]The province is properly designated as Newfoundland and Labrador; the Island as Newfoundland.

coastal waters are remarkably clear with visibility usually better than 30 feet.

Although Newfoundland is farther south than the British Isles, its climate and surrounding waters are cooler. The Labrador Current flows southward from Baffin Bay along the coast of Labrador and along the eastern shore of Newfoundland to the Grand Banks southeast of the Island where it converges with the Gulf stream which flows east-northeast. A small branch of the Labrador current leaves the main current north of the Island and enters the Strait of Belle Isle, moves into the Gulf of St. Lawrence and then southwestward through Cabot Strait between the southwestern tip of Newfoundland and the eastern end of Nova Scotia. These currents keep the surface waters surrounding the Island generally a little below 0° C during much of the winter season. During summer, the water temperatures vary between 14 and 18° C. The highest temperatures (20 to 22° C– in August) are found in small bays and estuaries. The surface water salinities on the open coast are lower than typical open ocean waters (i.e. they range from 32 to 33 o/oo) – primarily because of melting ice. Lower salinities occur in bays, harbours and estuaries which are fed by fresh-water streams. In many cases, the fresh water forms a surface layer with low salinity and high temperature.

Several types of marine algal habitats can be distinguished in Newfoundland depending upon the degree of wave action: exposed open coasts; semi-exposed beaches or coves; sheltered harbours, bays, or estuaries. The open coastal areas are subjected to heavy wave action and exhibit a pronounced zonation of plants and animals. A variety of red, brown and green algae is present in the littoral zone; various kelps (particularly *Alaria esculenta*) and red algae dominate the sublittoral zone. The substrate in such areas usually consist of large boulders or rocky ledges. Numerous coves interrupt the open coast line. They are formed by small streams and are bordered by steep rocky cliffs. Wave action is reduced, but the scouring effects of ice action are often conspicuous. A variety of fucoids can be found in the lit-

toral zone, as well as various green and brown algae. *Alaria esculenta* is not a dominant component of the sublittoral zone. The substrate at the headlands of the coves consists of coarse sand or pebbles with scattered boulders. Sheltered harbours, bays or estuaries form the upper arms of larger bays — e.g. Conception or Trinity Bay. The vegetation in the littoral zone is dominated by *Ascophyllum nodosum*, *Fucus vesiculosus*, filamentous brown and many green algae. *Dictyosiphon foeniculaceus*, *Chordaria flagelliformis*, *Chorda filum*, *Ahnfeltia plicata*, *Chondrus crispus*, *Polysiphonia* spp. and *Zostera marina* dominate the sublittoral zone. Their relative abundance varies with the type of substrate (small boulders, pebbles, sand and silt) and the degree of fresh water runoff. Mudflats form the upper ends of these sheltered locations, and relatively few species are found here except fucoids and green algae.

Results

A total of 155 species of marine algae was collected during the two trips to Newfoundland — including 10 Cyanophyta, 36 Chlorophyta, 47 Phaeophyta and 62 Rhodophyta. The following annotated list of species includes some synonymy, the collection sites, habitat notes, noteworthy taxonomic features and records of presently known geographical distribution along the Atlantic Coast of North America. The distribution of each species is designated numerically for its occurrence in one of the following geographical areas:

#1 Newfoundland northward
#2 Northern New England to Newfoundland or northward
#3 Southern New England to Newfoundland or northward
#4 New Jersey — Maryland to Newfoundland or northward
#5 North Carolina to Newfoundland or northward
#6 South Carolina to Newfoundland
#7 Tropics (at least Florida) to Newfoundland or northward

A Description of Stations follows the List of Species.

List of species

Cyanophyta

CYANOPHYCEAE

Chroococcales

CHROOCOCCACEAE

**Anacystis dimidiata* (Kützing) Drouet *et* Daily[4]

Occasional as an epiphyte on *Rhizoclonium riparium* which was growing on woodwork in the littoral zone at Forest Field. #7

[4]**Not previously recorded from Newfoundland.

Gomphosphaeria aponina Kützing

Mixed with *Rhizoclonium riparium* on woodwork in the littoral zone at Forest Field. #7

ENTOPHYSALIDACEAE

Chlorogloea conferta (Kützing) Setchell *et* Gardner *ex* Gardner

(= *Entophysalis conferta* (Kützing) Drouet *et* Daily)

Found as an epiphyte on *Ceramium areschougii* at Ship Harbour and on *Rhodymenia palmata* and other algae at Marystown. #7

**Entophysalis granulosa* Kützing

(= *Entophysalis deusta* (Meneghini) Drouet *et* Daily)

On the intergenicula of *Corallina officinalis* at Dog Cove. #7

Nostocales

OSCILLATORIACEAE

**Lyngbya confervoides* (C. Agardh) Gomont

Found once as an epiphyte on *Enteromorpha intestinalis* at O'Donnell's Beach. #7

**Microcoleus tenerrimus* Gomont

Mixed with *Rhizoclonium riparium* on woodwork in the littoral at Forest Field. #7

**Schizothrix calcicola* (C. Agardh) Gomont

Found as an epiphyte on *Ceramium areschougii* at Ship Harbour, and on pier pilings at Big Barachois. #7

**Spirulina subsalsa* (Oersted) Gomont
Mixed with mats of *Rhizoclonium* spp. at Forest Field. #7

RIVULARIACEAE

**Calothrix confervicola* ((Roth) C. Agardh) Bonet *et* Flahault
Found twice; once as an epiphyte on *Ceramium areschougii* at Ship Harbour and once as an epiphyte on *Polysiphonia flexicaulis* at Boswarlos (a). Probably of world wide distribution, but apparently not recorded previously from Newfoundland. #7

**Calothrix crustacea* (Thuret) Bornet *et* Flahault
Found on rocks, pier pilings and on various plants in the littoral zone at Harbour Grace (c), Sweet Bay, Embree, Laurenceton and Margaree. #7

Chlorophyta

CHLOROPHYCEAE

Chlorococcales

CHLOROCOCCACEAE

Codiolum pusillum (Lyngbye) Kjellman in Foslie f. *longipes* (Foslie) Collins
Forming blackish-green patches on rocks in the upper littoral zone at Renews, Ship Cove and Carbonear Island. #2

Tetrasporales

PALMELLACEAE

Gloeocystis scopulorum Hansgirg
Forming a blackish-green layer on rocks in the littoral zone (mixed with *Ulothrix flacca*) at Great Paradise. #2

Ulotrichales

CHAETOPHORACEAE

**Entocladia wittrockii* Wille
Found within the cell walls of *Elachista fucicola*, which in turn was growing on *Ascophyllum nodosum* in the eulittoral zone at Great Paradise. #3

**Pilinia lunatiae* Collins
On a shell of *Lunatia heros* in the eulittoral zone at Big Barachois. #2

Pringsheimiella scutata (Reinke) Marchew
Found as an epiphyte on *Polysiphonia lanosa* at Point Crewe and on *Ceramium rubrum* at Dog Cove. #7

**Pseudendoclonium marinum* (Reinke) Aleem *et* Schulz
(= *Protoderma marinum* Reinke in Taylor, 1957)
Uncommon; found on rocks in the mid and lower eulittoral at Placentia Sound, Sweet Bay, mouth of Gander River and Gander Bay, Embree, Davidsville (b), and Glenburnie (a). #7

ULOTRICHACEAE

**Stichococcus marinum* (Wille) Hazen
Free filaments entangled in *Elachista fucicola*, which in turn was epiphytic on *Ascophyllum nodosum*, at Great Paradise. #3

Ulothrix flacca (Dillwyn) Thuret in Le Jolis
Found as an epiphyte on *Fucus vesiculosus* and *Ascophyllum nodosum*, and on rocks in the littoral zone at Great Paradise. #4

ULVACEAE

**Capsosiphon fulvescens* (C. Agardh) Setchell *et* Gardner
Occasional on mud covered rocks in the littoral zone of protected coves and bays — particularly in brackish water areas. Collected at Marystown, Milton, Lethbridge (a), Sweet Bay, mouth of Gander River and Gander Bay, Big Cove, Brown's Arm, Laurenceton, all stations in Humber Arm, York Harbour, Boswarlos (a), Winter House, and Woody Point. #4

**Enteromorpha erecta* (Lyngbye) J. Agardh
Found on scattered rocks in the littoral zone of mud flats at Brown's Arm and the mouth of the Gander River and Gander Bay. #3

Enteromorpha groenlandica (J. Agardh) Setchell *et* Gardner
Found as an epiphyte on *Cladophora flexuosa* at Lethbridge (a) and on pier pilings at Big Barachois. #2

Enteromorpha intestinalis (L.) Link
Common on rocks in the upper-middle eulittoral zone — particularly in areas of fresh water run-off. Collected at O'Donnell's Beach, Salmonier Arm, Port au Bras, Lawn, Brigus Bay, Hant's Harbour, Adeyton, Lethbridge (a), Sweet Bay, mouth of Gander River and Gander Bay,

Davidsville (b), Noggin Cove, Embree, Brown's Arm, Humber Arm (a, b), Benoit's Cove, Stephenville Crossing, Boswarlos (a, b), Winter House and Glenburnie. #7

**Enteromorpha linza* (L.) J. Agardh

Occasional on rocks in the eulittoral and upper sublittoral at Trepassey Harbour (b), Point Verde, Cuslett, Garnish, Harbour Grace (c), Sweet Bay and Frenchman's Cove. #7

Enteromorpha micrococca Kützing

Found on rocks and pier pilings in the littoral fringe and upper eulittoral at Renews, Harbour Grace (c), Sweet Bay and Glenburnie. #2

Enteromorpha minima Nägeli

(= *Blidingia minima* (Nägeli *ex* Kützing) Kylin)

Found once on boulders in the upper eulittoral-littoral fringe at Long Beach. #7

**Enteromorpha plumosa* Kützing

Found entangled amongst other algae in the eulittoral zone at Marystown, and in a high, marshy tide pool at the mouth of the Gander River and Gander Bay. #7

**Enteromorpha prolifera* (O. F. Müller) J. Agardh

Found on rocks in the eulittoral zone at Marystown. #7

Monostroma fuscum (Postels *et* Ruprecht) Wittrock

f. *blyttii* (Areschoug) Collins

Present on rocks and as an epiphyte in the lower eulittoral and sublittoral at Trepassey Harbour (a), Lawn, and Hant's Harbour. #3

Monostroma grevillei (Thuret) Wittrock

On rocks in the eulittoral zone at Big Barachois. #3

Monostroma oxyspermum (Kützing) Doty

On rocks in the eulittoral zone at Marystown. #7

Monostroma pulchrum Farlow

Collected once as an epiphyte on *Chondrus crispus* in the lower eulittoral at Margaree. #3

**Percursaria percursa* (C. Agardh) Rosenvinge

Found on scattered rocks and pier pilings in the upper eulittoral zone of muddy bays — particularly brackish water areas. Collected at Noggin Cove, Marystown and Embree where it was mixed with *Enteromorpha* and *Rhizoclonium* spp. #4

CLADOPHORALES

CLADOPHORACEAE

Chaetomorpha atrovirens Taylor
Found as entangled mats amongst various plants in the sublittoral and lower eulittoral zones at Riverhead, Salmonier Arm, Tickles, Dog Cove, St. Mary's, Ship Harbour and Bloomfield. Specimens listed here are distinguished according to the characteristics given by Taylor (1957). However, we are not convinced that *C. atrovirens* and *C. linum* are distinct, for there is considerable variation of color and size in natural populations of this complex. #3

**Chaetomorpha linum* (O. F. Müller) Kützing
Found mixed with *C. atrovirens* in the sublittoral zone at Salmonier Arm, and entangled amongst other algae in Placentia Sound. #7

**Chaetomorpha melagonium* (Weber *et* Mohr) Kützing
Present on boulders and vertical ledges in the lower eulittoral and sublittoral zones at Placentia Sound, Branch, Harbour Mille and Margaree. #4

Cladophora flexuosa (O. F. Müller) Harvey
(= *C. sericea* (Hudson) Kützing sensu van den Hoek)
Present on rocks in high tide pools or on scattered rocks in the littoral zone at Riverhead, Salmonier Arm, St. Mary's Harbour, Marystown, Lethbridge (a) and Brown's Arm. Often mixed with *C. gracilis*. #7

Cladophora gracilis (Griffiths *ex* Harvey in Mackay) Kützing
(= *C.sericea* (Hudson) Kützing sensu van den Hoek)
In high tide pools or on scattered rocks in the littoral zone at Salmonier Arm, Bloomfield, Hant's Harbour, Lethbridge (d), mouth of Gander River and Gander Bay, Benoit's Cove, Bloomfield, and Margaree. #4

Cladophora ruprestris (L.) Kützing
Entangled amongst other algae along the town front at Marystown. #3

**Rhizoclonium kerneri* Stockmayer
Entangled amongst other algae in the mud flat area at Marystown. #7

**Rhizoclonium riparium* (Roth) Harvey
v. *implexum* (Dillwyn) Rosenvinge
Found as free-floating masses or entangled mats amongst various plants throughout the eulittoral zone; however, it is often most conspicuous in high, marshy tide pools. Collected at Trepassey Harbour, O'Donnell's Beach, Forest Field, Hant's Harbour, Milton, Gull Cove, Lethbridge (a), Sweet Bay, Bloomfield, mouth of the Gander River and Gander Bay, Embree and Margaree. #7

**Rhizoclonium tortuosum* Kützing
Found as an epiphyte and on rocks in the lower eulittoral at Riverhead, St. Mary's Harbour and Point Crewe. #4

Spongomorpha arcta (Dillwyn) Kützing
Relatively common on rocks in the lower eulittoral and upper sublittoral at Bay Bulls, Ferryland, Trepassey Harbour (b), Salmonier Arm, Point Verde, Branch, Gooseberry Cove, Ship Cove, Red Harbour, Port au Bras, Garnish, Carbonear Island, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Lethbridge (a, c), Bloomfield and Margaree. #4

Spongomorpha hystrix Strömfelt
Found on rocks in shallow water at Ferryland and the east coast of the Avalon Peninsula. #2

Spongomorpha lanosa (Roth) Kützing
Found once on rocks in the lowest eulittoral at Laurencetton. #3

**Spongomorpha spinescens* Kützing
Collected twice on rocks in the lowest eulittoral at Trepassey Harbour and Brigus Bay. #2

Urospora collabens (C. Agardh) Holmes *et* Batters
On woodwork in the littoral zone at Dog Cove. #2

Urospora penicilliformis (Roth) Areschoug
Found once on a pier piling at Harbour Grace (c); mixed with various blue green algae in the littoral fringe and upper eulittoral. #4

Phaeophyta
PHAEOPHYCEAE
Ectocarpales
ECTOCARPACEAE

Ectocarpus confervoides (Roth) Le Jolis
(= *E. arctus* Kützing in Parke and Dixon, 1964)
Common as an epiphyte on various plants in the eulittoral and upper sublittoral — less common on rocks; collected at Ferryland, Trepassey Harbour (a, b), St. Mary's, Salmonier Arm, Point Verde, Red Harbour, Port au Bras, Garnish, Spread Eagle, Kelly's Island (b), Bell Island, Carbonear Island, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Shoal Harbour, Lethbridge (c), mouth of Gander River and Gander Bay, Laurenceton, Humber Arm (b), Frenchman's Cove stations and Woody Point. #7

**Ectocarpus fasciculatus* Harvey
Found as an epiphyte on various plants in the lower eulittoral-upper sublittoral at St. Mary's, Point Verde, Gooseberry Cove and Margaree. #4

Ectocarpus siliculosus (Dillwyn) Lyngbye
Found occasionally as an epiphyte on *Chorda filum* and *Chordaria flagelliformis* in the lower eulittoral-upper sublittoral at St. Mary's, Salmonier Arm, Lawn, Harbour Grace (a), Kings Beach, Sweet Bay, Humber Arm (b) and Frenchman's Cove (b). #7

**Ectocarpus tomentosus* (Hudson) Lyngbye
Found as an epiphyte and entangled amongst other algae in the eulittoral and sublittoral at Trepassey Harbour (b), Salmonier Arm, Placentia Sound, Spread Eagle and York Harbour. #4

**Giffordia granulosa* (J. E. Smith) Hamel
On rocks in the sublittoral zone at Dog Cove. #4

**Giffordia ovata* (Kjellman) Kylin
On *Chordaria flagelliformis* from the mainland west of Chamber's Island. #3

**Giffordia sandriana* (Zanardini) Hamel

Found once on rocks in the eulittoral zone at Trepassey Harbour (b). #3

Pilayella littoralis (L.) Kjellman

A common epiphyte on *Ascophyllum nodosum* and Fucus spp. in the mid-lower eulittoral; occasionally on rocks. Collected at Bay Bulls, Ferryland, Trepassey Harbour (a, b), St. Mary's, O'Donnell's Beach, Salmonier Arm, Point Verde, Perch Cove, Branch, Gooseberry Cove, Port au Bras, Grand Bank, Foxtrap, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Adeyton, Lethbridge (a), Sweet Bay, Bloomfield, Big Cove, Laurenceton, Humber Arm (b), Stephenville Crossing, Frenchman's Cove (b) and Margaree. #4

RALFSIACEAE

**Ralfsia clavata* (Harvey in Hooker) Crouan frat.

Found once on the intergenicula of *Corallina officinalis*, which was growing in the upper sublittoral at Kelley's Island (b). #4

Ralfsia fungiformis (Gunner) Setchell *et* Gardner

Found once on rocks in the lower eulittoral at Lethbridge (b) mixed with *Ralfsia verrucosa*. #2

Ralfsia verrucosa (Areschoug) J. Agardh

Common on rocks and shells (often in tide pools) throughout the eulittoral zone at Trepassey Harbour (a), Salmonier Arm, Tickles, Little St. Lawrence Harbour, Dildo, Spread Eagle, Hant's Harbour, Adeyton, Lethbridge (a-c), Sweet Bay, Bloomfield, mouth of Gander River and Gander Bay, Embree, Big Cove, Laurenceton and Humber Arm (a). #4

SPHACELARIALES

SPHACELARIACEAE

Sphacelaria cirrosa (Roth) C. Agardh

Found on pier pilings in the mid-low eulittoral zone at Laurenceton and as an epiphyte on *Polysiphonia nigrescens* in the sublittoral at Frenchman's Cove (b). #3

Sphacelaria racemosa Greville v. *arctica* (Harvey) Reinke

Found once on mud covered rocks in the eulittoral at Humber Arm (a). #1

Sphacelaria plumosa Lyngbye
(= *Chaetopteris plumosa* (Lyngbye) Kützing in Taylor, 1957)
Found once as an epiphyte on *Dictyosiphon foeniculaceus* in the lower eulittoral at Laurenceton. #2

STYPOCAULACEAE
Halopteris scoparia (L.) Sauvageau
Found on scattered rocks (often sand covered) in the sublittoral zone at Frenchman's Cove (b) and Boswarlos (a). #2

TILOPTERIDALES

TILOPTERIDACEAE
**Haplospora globosa* Kjellman
A single gametophytic specimen was collected from a rock in the upper sublittoral at Gooseberry Cove; mixed with *Porphyra miniata*, *Ceramium rubrum*, and *Rhodomela confervoides*. #3

CHORDARIALES

CHORDARIACEAE
Chordaria flagelliformis (O. F. Müller) C. Agardh
Common on rocks (often mud covered) in the lower eulittoral-upper sublittoral zone; occasionally as an epiphyte in the same zone. Often mixed with *Dictyosiphon foeniculaceus* and difficult to distinguish from it in the field. Collected at Bay Bulls, Ferryland, Trepassey Harbour (a, b), St. Mary's, O'Donnell's Beach, Salmonier Arm, Tickles, Point Verde, Ship Harbour, Cuslett, Gooseberry Cove, Ship Cove, Red Harbour, Port au Bras, Lamaline, Grand Bank, Garnish, North Harbour, Foxtrap, Bell Island, Carbonear Island, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Shoal Harbour, Lethbridge (a, b), Sweet Bay, Embree, Big Cove, Humber Arm (c), Frenchman's Cove (b), Margaree, Bottle Cove and Boswarlos (a, b). #4
Eudesme virescens (Carmichael *ex* Harvey in Hooker) J. Agardh
Found once growing on rocks in the lower eulittoral at Trepassey Harbour (a). #3

**Eudesme zosterae* (J. Agardh) Kylin
Epiphytic on *Zostera marina* in the sublittoral zone at Salmonier Arm and Spread Eagle; also on stones along the town front at Marystown. #7

Sphaerotrichia divaricata (C. Agardh) Kylin
On rocks (often mud covered) and epiphytic on *Fucus vesiculosus* in the eulittoral and sublittoral zones of protected bays at Lethbridge (a, c, d), Embree and Big Cove. #4

CORYNOPHLAEACEAE

Leathesia difformis (L.) Areschoug
Epiphytic on *Corallina officinalis* and other plants in the lower eulittoral-upper sublittoral zone at Lamaline and Margaree. #5

ELACHISTACEAE

Elachista fucicola (Velley) Areschoug
A common epiphyte on *Ascophyllum nodosum* and *Fucus* spp. from the mid eulittoral to the upper sublittoral at Bay Bulls, Ferryland, Trepassey Harbour (a, b), O'Donnell's Beach, Point Verde, Parker's Cove, Port au Bras, Harbour Mille, Spread Eagle, Kelley's Island (b), Brigus Bay, Hant's Harbour, Long Beach, Adeyton, Lethbridge (c), Sweet Bay, mouth of Gander River and Gander Bay, Noggin Cove, Big Cove, Brown's Arm, Frenchman's Cove (b), Margaree and Boswarlos (b). #4

Elachista lubrica Ruprecht
Growing on fucoids in the sublittoral zone (on a pier piling) at Marystown. #2

MYRIONEMATACEAE:

**Ascocyclus distromaticus* Taylor
*Found once as an epiphyte on *Zostera marina* in the sublittoral at Salmonier Arm. #3

**Myrionema strangulans* Greville
Found as an epiphyte (on *Enteromorpha erecta, Chaetomorpha atrovirens* and kelps) at the mouth of the Gander River and Gander Bay, Placentia Sound, Gooseberry Cove, Harbour Mille, Kelly's Island (b), Bay Bulls and Trepassey Harbour (b). #5

DESMARESTIALES

DESMARESTIACEAE

Desmarestia aculeata (L.) Lamouroux
On rocks in the sublittoral zone at Trepassey Harbour (b), Salmonier Arm, Dog Cove, Ship Cove, Garnish, Bell Island, Carbonear Island, Brigus Bay and Shoal Harbour. #4
Desmarestia viridis (O. F. Müller) Lamouroux
On rocks in the sublittoral zone at Ferryland, Trepassey Harbour (a), St. Mary's, Salmonier Arm, Dog Cove, Gooseberry Cove, Grand Bank, Harbour Mille, Spread Eagle, Foxtrap, Kelly's Island (b), Bell Island, Carbonear Island, Hant's Harbour and Margaree. #4

DICTYOSIPHONALES

DICTYOSIPHONACEAE

**Dictyosiphon ekmanii* Areschoug
On rocks in shallow water at Big Barachois. #2
Dictyosiphon foeniculaceus (Hudson) Greville
Very common on mud covered rocks in the lower eulittoral-upper sublittoral — particularly in sheltered bays. Often mixed with *Chordaria flagelliformis* which is difficult to distinguish in the field. Collected at Bay Bulls, Ferryland, Trepassey Harbour (a, b), St. Mary's, O'Donnell's Beach (a), Salmonier Arm, Tickles, Point Verde, Patrick's Cove, Placentia Sound, Gooseberry Cove, Ship Cove, Red Harbour, Port au Bras, Little St. Lawrence Harbour, Lamaline, North Harbour, Dildo, Foxtrap, Kelly's Island (b), Bell Island, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Adeyton, Shoal Harbour, Lethbridge (a, c), Sweet Bay, Bloomfield, mouth of Gander River and Gander Bay, Embree, Big Cove, Laurenceton, Humber Arm (b), Frenchman's Cove (b), Margaree, Boswarlos (a, b) and Woody Point. #4

PUNCTARIACEAE

Asperococcus echinatus (Mertens) Greville
Found once on rocks in a mid-eulittoral tide pool at Hant's Harbour. #3
**Delamarea attenuata* (Kjellman) Rosenvinge

On rocks in the eulittoral zone at Bay Bulls, Point Verde, Ship Cove, Long Beach, Shoal Harbour and Margaree. #3

**Myriotrichia filiformis* Harvey

Found as an epiphyte on *Cystoclonium purpureum* from the mainland west of Chamber's Island, and on *Dictyosiphon foeniculaceus* from Placentia Sound. #4

**Punctaria latifolia* Greville

Found on scattered rocks in the eulittoral zone at Port au Bras, North Harbour and Dildo. #4

**Punctaria plantaginea* (Roth) Greville

Uncommon, on rocks in the eulittoral zone at Long Harbour, Lamaline and Frenchman's Cove (b). #4

SCYTOSIPHONACEAE

Petalonia fascia (O. F. Müller) Kuntze

On rocks (often in tide pools) and epiphytic on various algae in the eulittoral zone at Trepassey Harbour (b), Cuslett, Gooseberry Cove, Port au Bras, Lawn, Garnish, Bacon Cove; Carbonear Island, Hant's Harbour, Long Beach and Sweet Bay. The variety *zosterifolia* was found once at Renews. #7

**Scytosiphon lomentarius* (Lyngbye) Link

On rocks (often in tide pools) and occasionally epiphytic on various plants in the eulittoral zone at St. Mary's, Ship Cove, Grand Bank, Garnish, Foxtrap, Kelly's Island (b) and Carbonear Island. #5

STRIARIACEAE

Stictyosiphon tortilis (Ruprecht) Reinke

Present on rocks and pier pilings in the eulittoral and upper sublittoral zones of the protected bays at Brown's Arm, and Laurenceton. Mixed with *Enteromorpha* spp, *Chordaria flagelliformis* and *Dictyosiphon foeniculaceus*. #2

LAMINARIALES

ALARIACEAE

Alaria esculenta (L.) Greville

(including *A. musaefolia* (De la Pylaie) J. Agardh sensu Widdowson, 1964). Relatively common in the sublittoral zone (usually below 3 feet) of rocky exposed coastal areas.

Collected at Bay Bulls, Trepassey Harbour (b), St. Mary's, Point Verde, Branch, Cuslett, Gooseberry Cove, Ship Cove, Red Harbour, Grand Bank, Carbonear Island, Brigus Bay, Hant's Harbour, Long Beach, Dog Cove and Margaree. #3

CHORDACEAE

Chorda filum (L.) Stackhouse

Common on small rocks and shells in the sublittoral zone of sheltered bays and harbours. Collected at Trepassey Harbour stations, Riverhead, O'Donnell's Beach (a), Salmonier Arm, Dog Cove (adrift), Point Verde, Red Harbour, Port au Bras, Little St. Lawrence Harbour, Lawn, Garnish, Harbour Mille, Dildo, Spread Eagle, Foxtrap, Bell Island, Harbour Grace (a), Brigus Bay, Hant's Harbour, Adeyton, Lethbridge (a-d), Sweet Bay, mouth of Gander River and Gander Bay, Embree, Big Cove, Brown's Arm, Laurenceton, Humber Arm (b), Frenchman's Cove (a, b), York Harbour, Bottle Cove, Boswarlos (b) and Woody Point. #4

LAMINARIACEAE

Agarum cribrosum (Mertens) Bory

Common in the sublittoral zone of exposed and semi-exposed areas below 5 feet. It doesn't appear to be eaten by urchins which were usually found in large numbers in the same areas. Collected at Trepassey Harbour (b), St. Mary's, Point Verde, Lamaline, Point Crewe, Lories, Burin Peninsula, Foxtrap, Kelly's Island (b), Carbonear Island, Harbour Grace (a), Brigus Bay, Hant's Harbour, and Margaree. #2

**Laminaria digitata* (Hudson) Lamouroux

Present in the sublittoral zone of rocky exposed coastal areas. Collected at Branch, Cuslett, Gooseberry Cove, Grand Bank, Harbour Mille and Brigus Bay. Frond segmentation varies considerably on different specimens, but each has a consistent + — anatomy (i.e. mucilage ducts are present in the blades and absent from the stipes, Wilce, 1965). #3

**Laminaria nigripes* J. Agardh
Found in the same exposed rocky habitat as *L. digitata*, but it was much less common. Collected at Margaree and Red Rock Point. It has a + + anatomy (Wilce, 1965). #1

Laminaria saccharina (L.) Lamouroux sensu Wilce
The plants designated here are of three ecotypes (Wilce, 1965), which are distinguished according to their anatomy (i.e. + +, + − and − −). They are found on rocks in the sublittoral zone of exposed or semi-exposed coastal areas. The + − ecotype (*L. saccharina* (L.) Lamouroux, in Taylor, 1957) was the least common of the three and it it was only found at Little St. Lawrence Harbour. The + + ecotype (*L. groenlandica* Rosenvinge in Taylor, 1957) was found at North Harbour, Carbonear Island and Margaree. The − − ecotype (*L. agardhii* Kjellman, in Taylor, 1957) was the most common of the three and was found at all the Trepassey Harbour stations, St. Mary's, Riverhead, Salmonier Arm, Tickles, Ship Harbour, Lawn, Lamaline, Spread Eagle, Brigus Bay and Bloomfield. The − − and + + ecotypes (as they are designated by Taylor, 1957) have not previously been recorded in Newfoundland. #4

Saccorhiza dermatodea (De la Pylaie) J. Agardh
On rocks in the sublittoral zone of exposed coastal areas. Collected at Ferryland, O'Donnell's Beach, Point Verde, Branch, Gooseberry Cove, Ship Cove, Lamaline, Garnish, Harbour Mille, Bacon Cove, Bell Island, Carbonear Island, Brigus Bay, Frenchman's Cove (b), Margaree and Bottle Cove. #2

Fucales

FUCACEAE

Ascophyllum nodosum (L.) Le Jolis
Very common on rocks from the mid eulittoral to the upper sublittoral at semi-exposed coastal and sheltered locations. Collected at Bay Bulls, Trepassey Harbour stations, Riverhead, O'Donnell's Beach, Salmonier Arm, Parker's Cove, Port au Bras, Spread Eagle, Foxtrap, Hant's Harbour, Adeyton, Lethbridge (a-c), Sweet Bay, Bloomfield, mouth

of the Gander River and Gander Bay, Noggin Cove, Embree, Big Cove, Laurenceton, Humber Arm (b), Benoit's Cove, Frenchman's Cove (b), Margaree, Boswarlos (a), Winter House, Glenburnie and Woody Point. #5

Fucus distichus (L.) emend, Powell ssp. *distichus* Powell
On rocks in high eulittoral tide pools at Big Barachois, Garnish, Carbonear Island, Hant's Harbour, Big Cove and Margaree. #2

Fucus distichus (L.) emend. Powell ssp. *edentatus* (De la Pylaie) Powell
Found twice on rocks in the lower eulittoral — upper sublittoral at Hant's Harbour and Margaree. #4

Fucus distichus (L.) emend. Powell ssp. *evanescens* (C. Agardh) Powell
On a vertical rock wall in the lower eulittoral at Bacon Cove. #3

Fucus vesiculosus L.
Common on rocks from the mid eulittoral to the upper sublittoral at semi-exposed coastal and sheltered areas. Collected at Bay Bulls, Ferryland, Trepassey Harbour stations, Riverhead, O'Donnell's Beach, Salmonier Arm, Tickles, Point Verde, Ship Harbour, Cuslett, Parker's Cove, Port au Bras, Lamaline, Grand Bank, Garnish, Harbour Mille, Dildo, Spread Eagle, Foxtrap, Kelly's Island (b), Carbonear Island, Harbour Grace (c), Brigus Bay, Hant's Harbour, Long Beach, Adeyton, Shoal Harbour, Lethbridge (a-d), Sweet Bay, Bloomfield, mouth of Gander River and Gander Bay, Noggin Cove, Mason's Cove, Embree, Big Cove, Brown's Arm, Laurenceton, Humber Arm (a, b), Benoit's Cove, Frenchman's Cove, Margaree, Stephenville Crossing, Boswarlos (a, b), Winter House, Glenburnie and Woody Point. #5

Rhodophyta

RHODOPHYCEAE

BANGIOPHYCIDAE

GONIOTRICHALES

GONIOTRICHACEAE

**Asterocystis ramosa* (Thwaites in Harvey) Gobi *ex* Schmitz.

Found once epiphytic on *Ceramium areschougii* at Ship Harbour. #7

**Goniotrichum alsidii* (Zanardini) Howe

Epiphytic on various plants in the eulittoral and sublittoral zones of sheltered locations. Collected at Salmonier Arm, Great Paradise, Dog Cove, Placentia Sound, Point Verde, Lethbridge (a, c), Bloomfield, Brown's Arm, Humber Arm (b), Frenchman's Cove (b) and Boswarlos (a, b). #7

BANGIALES

BANGIACEAE

**Bangia ciliaris* Carmichael

Found as an epiphyte on larger algae at Marystown, Topsail Beach, Hant's Harbour and Bloomfield. #4

Porphyra miniata (C. Agardh) C. Agardh

Growing on rocks or epiphytic on selected plants (e.g. *Chondrus crispus*, *Gigartina stellata*) in the lower eulittoral — upper sublittoral at all Trepassey Harbour stations, Point Verde, Branch, Gooseberry Cove, Ship Cove, Red Harbour and Lawn. #2

Porphyra umbilicalis (L.) J. Agardh

Found on rocks and epiphytic on various plants in the eulittoral zone at St. Mary's, Branch, Green Point, Gooseberry Cove, Ship Cove, Grand Bank, Point Verde, Port au Bras, Garnish, Harbour Mille, Dildo, Harbour Grace (c), Brigus Bay, Adeyton, Sweet Bay, Humber Arm (b), mouth of Gander River and Gander Bay, York Harbour, Winter House and Woody Point. The forma *epiphytica* Collins was also found on *Fucus vesiculosus* at Sweet Bay. #5

ERYTHROPELTIDACEAE

**Erythrotrichia carnea* (Dillwyn) J. Agardh

Found epiphytic on *Ceramium areschougii at* Ship Harbour and on various algae in front of the town at Marystown. #7

FLORIDEOPHYCIDAE

NEMALIONALES

ACROCHAETIACEAE

**Acrochaetium amphiroae* (Drew) Papenfuss

Found epiphytic on *Rhodymenia palmata* at Point Verde and Harbour Mille. #3

**Acrochaetium attenuatum* (Rosenvinge) Hamel, f.
Found epiphytic on *Chaetomorpha atrovirens* at Dog Cove. #3

**Acrochaetium flexuosum* Vickers
Found epiphytic on *Chaetomorpha atrovirens* from Placentia Sound. #7

**Kylinia alariae* (Jonsson) Kylin
Epiphytic on *Alaria esculenta* at Ferryland and at Port au Bras. #2

**Kylinia compacta* (Jao) Papenfuss
Found once epiphytic on *Cladophora gracilis* at Lethbridge (a). #3

**Kylinia hallandica* (Kylin) Kylin
Found once epiphytic on *Petalonia fascia* at Trepassey Harbour (b). #1

**Kylinia moniliformis* (Rosenvinge) Kylin
Epiphytic on *Giffordia ovata* in shallow waters along the mainland shore west of Chamber's Island. #3

**Kylinia secundata* (Lyngbye) Papenfuss
Growing as an epiphyte on *Sertularia*, which in turn was on *Fucus vesiculosus*, at St. Mary's. #3

**Kylinia virgatula* (Harvey) Papenfuss
Found once epiphytic on *Cladophora gracilis* at Lethbridge (a). #7

**Rhodochorton purpureum* (Lightfoot) Rosenvinge
In shaded rock crevices at Witless Bay and Gull Cove. #3

BONNEMAISONIACEAE

Trailliella intricata (J. Agardh) Batters
Epiphytic on various plants in the sublittoral zone of protected harbours or bays. Collected at Salmonier Arm, Point Verde, Ship Harbour, Cuslett, North Harbour, Frenchman's Cove (b), York Harbour and Stephenville Crossing. According to Harder (1948) *Trailliella intricata* is the tetrasporophyte of *Asparagopsis hamifera*. However, the latter plant is only recorded from Long Island and southern Massachusetts (Taylor, 1957). Chihara

(1961) has recently given an extensive review of the life history of the group. #3

CRYPTONEMIALES

CHOREOCOLACEAE

**Choreocolax polysiphoniae* Reinsch

Parasitic on *Polysiphonia lanosa*, which in turn was epiphytic on *Ascophyllum nodosum*. Collected at O'Donnell's Beach, Parker's Cove, Garnish and Margaree. #3

CORALLINACEAE

Clathromorphum circumscriptum (Strömfelt) Foslie

(As *Phymatolithon compactum* (Kjellman) Foslie in Taylor, 1957)

On rocks and shells in the lower eulittoral and sublittoral at St. Mary's, Salmonier Arm, Tickles, Branch, Hant's Harbour and Margaree. #2

Corallina officinalis L.

On rocks in eulittoral tide pools and in the sublittoral zone at Trepassey Harbour (b), Salmonier Arm, Tickles, Dog Cove, Point Verde, Cuslett, Gooseberry Cove, Ship Cove, Lamaline, Foxtrap, Kelly's Island (b), Carbonear Island, Hant's Harbour and Margaree. #2

Leptophytum laeve (Strömfelt) Adey

(= *Lithothamnium laeve* (Strömfelt) Foslie, in Taylor, 1957)

On stones in the upper sublittoral on the west side of Sound Island. #3

Lithothamnium glaciale Kjellman

On rock surfaces and shells in the lowest eulittoral and sublittoral at Riverhead, O'Donnell's Beach, Salmonier Arm, Lamaline, Foxtrap, Kelly's Island (b), Harbour Grace (a), Hant's Harbour and Sweet Bay. This plant forms a conspicuous residual cover in areas of heavy sea urchin grazing. #2

**Lithothamnium tophiforme* Unger

Found loose in shallow water at Ship Harbour. The validity of this species is subject to question (Adey, 1966). #2

**Phymatolithon rugulosum* Adey

Found once on rocks in the sublittoral zone at Salmonier Arm. #2

GLOIOSIPHONIACEAE

Gloiosiphonia capillaris (Hudson) Carmichael *ex* Berkeley

Found on rocks in the lower eulittoral — upper sublittoral at Branch and Gooseberry Cove; also found epiphytic on *Chordaria flagelliformis* from the mainland west shore of Chamber's Island. #3

HILDENBRANDIACEAE

Hildenbrandia prototypus Nardo

On rock surfaces and shells in the eulittoral and upper sublittoral zones at Trepassey Harbour (a), Salmonier Arm, Placentia Sound, Parker's Cove, Spread Eagle, Lethbridge (a-c), Sweet Bay, Bloomfield, mouth of Gander River and Gander Bay, Embree, Big Cove and Humber Arm (a). #7

POLYIDEACEAE

**Polyides rotundus* (Hudson) Greville

(= *Polyides caprinus* (Gunnerus) Papenfuss in Taylor, 1957)

On stones in the sublittoral zone at Perch Cove. #3

SQUAMARIACEAE

**Rhodophysema elegans* (Crouan frat *ex* J. Agardh) Dixon (including *Rhododermis parasitica* Batters sensu Dixon, 1964)

Present on rocks in the lower eulittoral zone at Sweet Bay, epiphytic on *Spongomorpha arcta* in the eulittoral zone at Salmonier Arm and Lethbridge (c) and at the base of *Ascophyllum nodosum* and on a vertical rock wall (eulittoral) at Placentia Sound. #2

**Rhodophysema georgii* Batters

(= *Rhododermis georgii* (Batters) Collins in Taylor, 1957)

Found once epiphytic on *Zostera marina* leaves in the sublittoral zone at Lethbridge (d). #3

GIGARTINALES

GIGARTINACEAE

Chondrus crispus Stackhouse

Relatively common on rocks in the eulittoral (usually the

lowest part) and sublittoral zones at all Trepassey Harbour stations, St. Mary's, Riverhead, O'Donnell's Beach, Salmonier Arm, Tickles, Point Verde, Ship Harbour, Cuslett, Parker's Cove, Red Harbour, Little St. Lawrence Harbour, Harbour Mille, North Harbour, Hant's Harbour, Shoal Harbour, all Lethbridge stations, Bloomfield, Embree, Humber Arm (b), Benoit's Cove, Margaree, Stephenville Crossing and Boswarlos (a). #4

Gigartina stellata (Stackhouse) Batters

On rock surfaces in the lower eulittoral and upper sublittoral at Trepassey Harbour (a) and Branch. #3

NEMASTOMATACEAE

**Platoma bairdii* (Farlow) Kuckuck

On stones in the lower eulittoral zone at Perch Cove. #3

PHYLLOPHORACEAE

Ahnfeltia plicata (Hudson) Fries

Present on rocks (often sand and mud covered) in the lower eulittoral and sublittoral at Salmonier Arm, Dog Cove, Branch, Placentia Sound, Cuslett, Gooseberry Cove, Shoal Harbour, Lethbridge (a, b), mouth of the Gander River and Gander Bay, Embree, Humber Arm (b) and Boswarlos (b). #4

Phyllophora brodiaei (Turner) Endl.

Found on rock surfaces in the sublittoral zone at Salmonier Arm; mixed with *P. membranifolia*. #4

Phyllophora membranifolia (Goodenough *et* Woodward) J. Agardh

Found in the sublittoral zone at Salmonier Arm. #4

RHODOPHYLLIDACEAE

Cystoclonium purpureum (Hudson) Batters

Growing as an epiphyte and on rocks in the sublittoral zone at O'Donnell's Beach, along mainland west of Chamber's Island, Point Verde, Ship Harbour, Branch, Harbour Mille and North Harbour. #4

RHODYMENIALES

RHODYMENIACEAE

Halosaccion ramentaceum (L.) J. Agardh

Relatively common on rock surfaces in the lower eulittoral

and upper sublittoral at Bay Bulls, Trepassey Harbour stations, Point Verde, Branch, Taylor Bay, Cuslett, Gooseberry Cove, Ship Cove, Red Harbour, Lawn, Harbour Mille, Bell Island, Carbonear Island, Brigus Bay, Hant's Harbour, Long Beach and Margaree. #2

Rhodymenia palmata (L.) Greville

On rocks and epiphytic on kelps in the sublittoral zone at Bay Bulls, Trepassey Harbour stations, Riverhead, O'Donnell's Beach, Salmonier Arm, Point Verde, Branch, Cuslett, Gooseberry Cove, Ship Cove, Red Harbour, Port au Bras, Little St. Lawrence Harbour, Harbour Mille, North Harbour, Bell Island, Carbonear, Harbour Grace (c), Brigus Bay and Margaree. #4

Ceramiales

Ceramiaceae

**Antithamnion americanum* (Harvey) Farlow in Kjellman

On woodwork in the eulittoral zone at Marystown. #4

**Antithamnion boreale* (Gobi) Kjellman

Found as an epiphyte on *Desmarestia aculeata* in the sublittoral zone at Brigus Bay. #2

**Antithamnion cruciatum* (C. Agardh) Nageli

Epiphytic on larger algae along the town front at Marystown. #7

Antithamnion pylaisaei (Montagne) Kjellman

Epiphytic on other algae along the town front of Marystown and at Perch Cove. #3

**Ceramium areschougii* Kylin

Found once in the sublittoral zone at Ship Harbour. #3

**Ceramium elegans* (Ducluzeau) C. Agardh

Found as an epiphyte on large algae at Marystown and Humber Arm (b). #2

**Ceramium rubriforme* Kylin

On *Chondrus crispus* along the mainland west of Chamber's Island; also at Dog Cove. #3

Ceramium rubrum (Hudson) J. Agardh

v. *pedicellatum* Duby

Collected on rocks in the lower eulittoral and sublittoral at Point Verde, Branch, and Gooseberry Cove. #7

**Plumaria elegans* (Bonnemaison) Schmitz
Mixed with *Membranoptera alata* around the bases of *Agarum cribrosum* in the lower eulittoral — upper sublittoral zones at several locations on the Burin Peninsula. #4

**Ptilota plumosa* (Hudson) C. Agardh
On rocks in the sublittoral zone at Point Crewes. #2

Ptilota serrata Kützing
On rocks and epiphytic on various plants (particularly the stipes and holdfasts of kelps) in the sublittoral zone at Point Verde, Branch, Brigus Bay, Hant's Harbour, York Harbour, Stephenville Crossing and the Burin Peninsula. #4

DELESSERIACEAE

**Membranoptera alata* (Hudson) Stackhouse
(including *Membranoptera denticulata* (Montagne) Kylin in Taylor, 1957). Found as an epiphyte on *Desmarestia aculeata* in the sublittoral zone at Brigus Bay and mixed with *Plumaria elegans* around the bases of *Agarum cribrosum* at many locations on the Burin Peninsula. #2

Phycodrys rubens (Hudson) Batters
Found once on rocks in the sublittoral zone at Brigus Bay. #4

RHODOMELACEAE

**Polysiphonia arctica* J. Agardh
Found once on rocks in the sublittoral zone at Ship Harbour. #2

**Polysiphonia elongata* (Hudson) Greville *ex* Harvey in Hooker
On rocks in the upper sublittoral along the mainland shore west of Chamber's Island, and at Marystown. Fine branches were present throughout the summer. #3

**Polysiphonia fibrillosa* (Dillwyn) Harvey in Hooker
On rocks and epiphytic on various algae in the lower eulittoral and sublittoral at Point Verde, Kelly's Island (b), Sweet Bay, mouth of the Gander River and Gander Bay, Big Cove, and Humber Arm (b). #4

**Polysiphonia flexicaulis* (Harvey) Collins
On rocks and epiphytic on various algae in the lower

eulittoral and sublittoral at Salmonier Arm, Marystown, Garnish, Hant's Harbour, Lethbridge (c), Laurenceton and Boswarlos (a, b). #3

**Polysiphonia harveyi* Bailey
Found once epiphytic on *Chordaria flagelliformis* in the upper sublittoral zone at Hant's Harbour. #6
Polysiphonia lanosa (L.) Tandy
Epiphytic on *Ascophyllum nodosum* at O'Donnell's Beach, Parker's Cove, Garnish and Margaree. #4

**Polysiphonia nigra* (Hudson) Batters
Found once on rocks in the sublittoral zone at Salmonier Arm. #4

**Polysiphonia nigrescens* (Hudson) Greville
On rocks in the sublittoral zone of semi-exposed coasts (Hant's Harbour and Bell Island) and sheltered estuarine regions (Salmonier Arm, Brown's Arm, Humber Arm (b), Frenchman's Cove (b) and Stephenville Crossing). It is most common in the latter regions where it is mixed with *Chorda filum*, *Chordaria flagelliformis*, *Dictyosiphon foeniculaceus* etc. #6

**Polysiphonia novae-angliae* Taylor
Found once epiphytic on *Chordaria flagelliformis* in the sublittoral zone at Sweet Bay. #4
Polysiphonia urceolata (Lightfoot *ex* Dillwyn) Greville var *patens* (Dillwyn) Harvey
On rocks in the lowest eulittoral and sublittoral at Marystown, Point Verde, Perch Cove, Kelly's Island (b), Bell Island, Carbonear Island, Brigus Bay, Hant's Harbour and Sweet Bay. #4

Rhodomela confervoides (Hudson) Silva
On rocks in the lower eulittoral (often in tide pools) and in the sublittoral at Trepassey Harbour stations, Salmonier Arm, Point Verde, Branch, Cuslett, Gooseberry Cove, Ship Cove, Lawn, Harbour Mille, Kelly's Island (b), Carbonear Island, Brigus Bay, Hant's Harbour, Margaree and Stephenville Crossing. #4

Description of stations

Southern Shore

Bay Bulls: A semi-exposed bay approximately 2 miles long and ¾ mile wide with steep sides. The substrate consisted of large outcroppings. Sea urchins grazing and the scouring effects of ice were visible in the sublittoral zone. Visited August 2, 1967. (Approximate position: Lat. 47° 18′ N, Long. 52° 49′ W).

Witless Bay: A semi-exposed bay on the east coast of the Avalon Peninsula. Visited August 22, 1948. (Approximate position: Lat. 47° 18.5′, Long. 52° 51′ W).

Ferryland: A semi-exposed bay formed from a ridge of offshore islands. The substrate consisted of large boulders, which showed conspicuous ice scouring. Numerous sea urchins were evident. Visited August 22, 1948 and August 4, 1967. (Approximate position: Lat. 47° 01′ N, Long. 52° 53′ W).

Fermeuse: A sheltered bay (about 4 miles long and ½ mile wide) with a small creek flowing into it. Substrate of scattered boulders grading into mud (at the head). Visited August 4, 1967. (Approximate position: Lat. 46° 58.3′ N, Long. 52° 36.5′ W).

Renews: A sheltered cove with a large creek flowing into it. Substrate of scattered boulders grading into mud (at the head). Visited August 22, 1948 and August 4, 1967. (Approximate position: Lat. 46° 56′ N, Long. 52° 59′ W).

Cappahayden: An exposed open coastal shore. Substrate of large boulders grading into small stones. Visited August 22, 1948 and August 4, 1967. (Approximate position: Lat. 46° 52′ N, Long. 52° 56.6′ W).

Trepassey Bay

Trepassey Harbour (*a*): A semi-exposed area on Powles Peninsula (head) just south of the Observatory Station — outside of the berm. Substrate ranging from large boulders to small pebbles. In August 1967 the surface water salinity was 33.2 o/oo, and the temperature 15°C. Visited August 22, 1948 and August 4 & 5, 1967. (Approximate position: Lat. 46° 42.5′ N, Long. 53° 23.5′ W).

Trepassey Harbour (*b*) : A sheltered location in the northwest arm of Trepassey Bay — near the Fishery. An area of steep cliffs. Substrate ranging from small boulders to large rocks. Visited August 22, 1948 and August 5, 1967. (Approximate position: Lat. 46° 45′ N, Long. 53° 26′ W).
Biscay Bay: A sheltered bay due east of Trepassey Harbour. Visited August 22, 1948 and August 4, 1967. (Approximate position: Lat. 46° 47′ N, Long. 53° 18′ W).

St. Mary's Bay

St. Mary's: A semi-exposed beach with shingle-pebble and occasional rock outcrops — in St. Mary's Harbour. Ice scouring evident on rocks. Visited August 11, 1948 and August 6, 1967. (Approximate position: Lat. 46° 56′ N, Long. 53° 34′ W).
Coots Pound: A sheltered berm area enclosing a river outlet in St. Mary's Harbour. Substrate of shingle-pebbles and with occasional outcrops of boulders. Surface water salinity 32 o/oo, temperature 20°C. Visited August 6, 1967. (Approximate position: Lat. 46° 56.8′ N, Long. 53° 30.5′ W).
Riverhead: A sheltered area at the head of St. Mary's Harbour. Substrate of shingles-pebbles and with occasional boulders. Visited August 11, 1948 and August 6, 1967. (Approximate position: Lat. 46° 58′ N, Long. 53° 32′ W).
O'Donnell's Beach (*a*) : A sheltered beach with pebbles and boulders. Surface water salinity 34 o/oo, temperature 20°C. Visited August 6, 1967. (Approximate position: Lat. 47° 04.8′ N, 53° 33.5′ W).
O'Donnell's Beach (*b*) : A sheltered area 3½ miles south of O'Donnell's Beach; substrate of flat limestone ledges projecting into a sandy beach. Visited August 6, 1967. (Approximate position: Lat. 47° 05′ N, Long. 53° 37′ W).
Admiral's Beach: A sheltered beach with a shingle substrate. Surface water temperature 18°C. Visited August 6, 1967. (Approximate position: Lat. 47° 01′ N, Long. 53° 37′ W).
Salmonier Arm: A number of locations were examined in the sheltered bay. The substrate ranged from large boulders to pebbles, sand and silt from the mouth of the arm

to the river itself. On August 6, 1967 the surface water salinity ranged from 15 o/oo (at the head) to 35 o/oo (at the mouth), while the surface water temperatures ranged from 23°C (at the head) to 20°C (at the mouth). The following stations were occupied:

(a) 1½ miles south of Mt. Carmel — west side of the arm. Visited August 6, 1967. (Approximate position: Lat. 47° 07.8′ N, Long. 53° 31′ W).

(b) Mt. Carmel — west side of the arm. Collections were made at the pier near the church. Visited August 6, 1967. (Approximate position: Lat. 47° 08′ N, Long. 53° 30′ W).

(c) 1½ miles north of Mt. Carmel — west side of the arm. Visited August 6, 1967. (Approximate position: Lat. 47° 09.5′ N, Long. 53° 27′ W).

(d) 3 miles south of Salmonier River — west side of the arm. Visited August 6, 26 & 27, 1967. (Approximate position: Lat. 47° 10.3′ N, Long. 53° 26.5′ W).

(e) Forest Field — near St. Catherines on the east side of the arm. Visited August 4, 1968. (Approximate position: Lat. 47° 09.3′ N, Long. 53° 25.5′ W).

(f) 3 miles south of the Salmonier River — east side of the arm. Visited August 6, 1967. (Approximate position: Lat. 47° 07.5′ N, Long. 53° 26.5′ W).

(g) 1½ miles north of New Bridge — east side of the arm. Visited August 6, 1967. (Approximate position: Lat. 47° 08.5′ N, Long. 53° 28.5′ W).

(h) 1½ miles north of St. Joseph's Church — east side of the arm. Visited August 6, 1967. (Approximate position: Lat. 47° 07.5′ N, Long. 53° 29.5′ W).

Tickles: A sheltered berm area consisting of shingles-pebbles. Only a few large boulders were evident. Surface water salinity 33.3 o/oo, temperature 20°C. Visited August 7, 1967. (Approximate position: Lat. 47° 10.5′ N, Long. 53° 33.5′ W).

Dog Cove: A semi-exposed cove west of Cape Dog. Visited August 11, 1948. (Approximate position: Lat. 47° 02′ N, Long. 53° 44′ W).

Branch: A semi-exposed cove of about 1 mile in width.

Substrate ranged from rock ledges, pebbles to sand. In August, 1967, the water was of two layers: an upper silty, brackish and warmer layer (25 o/oo and 20°C) and a lower layer which was clear, more saline and colder (35 o/oo and 10°C). Visited August 12, 1948 and August 9, 1967. (Approximate position: Lat. 46° 53′ N, Long. 53° 59′ W).

Placentia Bay and the Extreme Southern Tip of the Burin Peninsula

Perch Cove: A semi-exposed cove on the eastern side of Placentia Bay — about 1.3 miles south of Cuslett. Visited August 12, 1948. (Approximate position: Lat. 46° 53′ N, Long. 54° 12′ W).

Cuslett: A small semi-exposed cove with steep rocky sides; approximately ½ mile long and wide. Substrate at the head of the cove consisted of pebbles. Visited August 12, 1948 and August 9, 1967. (Approximate position: Lat. 46° 54.5′ N, Long. 54° 10.5′ W).

Patrick's Cove: A semi-exposed cove approximately 6 miles north of Cuslett. Visited August 12, 1948. (Approximate position: Lat. 46° 59′ N, Long. 54° 07.5′ W).

Gooseberry Cove: A small semi-exposed cove with steep rocky sides; approximately ½ mile wide and ¾ mile long. Substrate of scattered boulders below the ledges. Visited August 9, 1967. Approximate position: Lat. 47° 03.9′ N, Long. 54° 06′ W).

Ship Cove: A small semi-exposed cove (approximately ¾ mile wide and 1 mile long) with the same topography and substrate as Gooseberry Cove except that the headland substrate was coarse sand. Visited August 12, 1948 and August 9, 1967. (Approximate position: Lat. 47° 06′ N, Long. 54° 03′ W).

Big Barachois: A sheltered beach at the mouth of the Big Barachois River. Visited August 12, 1948. (Approximate position: Lat. 47° 06′ N, Long. 54° 05′ W).

Green Point: A semi-exposed beach approximately 2 miles south of Placentia Harbour. Visited August 12, 1948. (Approximate position: Lat. 47° 11′ N, Long. 54° 03′ W).

Point Verde: An exposed open coastal site. Substrate con-

sisting of large boulders. Surface water salinity 35 0/00, temperature 17°C. Visited August 8, 1967. (Approximate position: Lat. 47° 14′ N, Long. 54° 00.5′ W).

Ferndale: A sheltered cove at the entrance to Placentia Harbour; with steep sides. Substrate of boulders and stones. Visited August 9, 1967. (Approximate position: Lat. 47° 13′ N, Long. 53° 54′ W).

Fox Harbour: A sheltered cove (approximately 15 feet deep) in Placentia Sound; polluted waters. Substrate of scattered boulders and mud. Visited August 9, 1967. (Approximate position: Lat. 47° 19.2′ N, Long. 53° 54.8′ W).

Ship Harbour: A semi-exposed harbour in Placentia Sound; with steep vertical sides; substrate of large boulders. Visited August 12, 1948 and August 9, 1967. In late August 1967 the surface water temperature was 15°C. (Approximate position: Lat. 47° 22′ N, Long. 53° 55′ W). The Placentia Sound area was also visited by Humm on August 13 and 15, 1948.

Long Harbour: A sheltered harbour on the northwest coast of the Avalon Peninsula. Visited August 13, 1948. (Approximate position: Lat. 47° 27′ N, Long. 53° 48′ W).

Arnold's Cove: A sheltered cove with long beaches and small cliffs. Substrate of scattered boulders. Surface water salinity 33.6 0/00, temperature 16°C. Visited August 12, 1967. Approximate position: Lat. 47° 45.8′ N, Long. 53° 59.4′ W).

North Harbour: A sheltered harbour with a flat sloping bottom. Substrate of silt-covered pebbles and limestone outcrops. Surface water salinity 32 0/00, temperature 18°C. Visited August 12, 1967. (Approximate position: Lat. 47° 50.8′ N, Long. 54° 06′ W).

Garden Cove: A sheltered area with a strong tidal current. Substrate of large boulders. Surface waters are turbid, brackish (18 0/00) and warm (20°C). Visited August 12, 1967. (Approximate position: Lat. 47° 50.8′ N, Long. 54° 50.8′ W).

Swift Current: A sheltered site west of Garden Cove; substrate of scattered boulders. Surface water temperature

20°C, salinity 30 0/00. Visited August 10, 1967. (Approximate position: Lat. 47° 53′ N, Long. 54° 15′ W).

Sound Island: Collections were made on the west side of the Island. Visited August 12, 1948. (Approximate position: Lat. 47° 47′ N, Long. 54° 13.5′ W).

Chamber's Island (west of): Collections were made along the mainland west of the Island. Visited August 15, 1948. (Approximate position: Lat. 47° 35′ N, Long. 54° 22′ W).

Haystack: A sheltered cove on the northeastern port of Long Island. Visited August 15, 1948. (Approximate position: Lat. 47° 37′ N, Long. 54° 07′ W).

Merasheen: A semi-exposed cove on the south-west corner of Merasheen Island. Visited August 15, 1948. (Approximate position: Lat. 47° 22′ N, Long. 54° 23′ W).

Long Island: An island about 1 mile wide and 4.7 miles long — due south of Petit Forte on the western side of Placentia Bay. Visited August 15, 1948. (Approximate position: Lat. 47° 19′ N, Long. 54° 42′ W).

Petit Forte: A sheltered coastal area due north of Long Island, and on the western side of Placentia Bay. Visited August 15, 1948. (Approximate position: Lat. 47° 20′ N, Long. 54° 42′ W).

Little Harbour: A sheltered harbour due west of Baine Harbour. Visited August 15, 1967. (Approximate position: Lat. 47° 18′ N, Long. 54° 48′ W).

Great Paradise: A semi-exposed site on the northwest coast of the Burin Peninsula. Visited August 15, 1948. (Approximate position: Lat. 47° 18′ N, Long. 54° 37′ W).

Parker's Cove: A sheltered cove (about 1 mile long). Collections were made from the pier and on scattered boulders. Surface water temperature 20° C, salinity 30 o/oo. Visited on August 10, 1967. (Approximate position: Lat. 47° 25′ N, Long 54° 50′ W).

Baine Harbour: A protected harbour with poor algal growth. Visited August 11, 1967. (Approximate position: Lat. 47° 22′ N, Long. 54° 55′ W).

Red Harbour: A semi-exposed rocky site with large rock outcrops and boulders. Surface water temperature 17° C,

salinity 25 o/oo. Visited on August 10, 1967. (Approximate position: Lat. 47° 17.5′ N, Long. 54° 59′ W).
Marystown: A sheltered site along the town front at Marystown; within Mortier Bay. Visited August 17, 1948. (Approximate position: Lat. 47° 10′ N, Long. 55° 10′ W).
Port au Bras: A semi-exposed cove with steep cliffs. Located about ½ mile south of the town. Visited on August 17, 1948 and August 11, 1967. In August 1967 the surface water salinity was 29 o/oo and the temperature 15° C. (Approximate position: Lat. 47° 14.3′ N, Long. 55° 08′ W).
Bull Cove: A rocky coastal area with polluted water and poor visibility. Visited on August 11, 1967. (Approximate position: Lat. 47° 03′ N, Long. 55° 09′ W).
Little St. Lawrence Harbour: A protected harbour. Collections were made in the north side of the harbour. The substrate (boulders) was covered with fine sediment. The water was of two layers: an upper silty, brackish and warmer layer (15 o/oo and 18° C) and a lower layer which was clear, more saline and colder (32.8 o/oo and 10° C). Visited on August 11, 1967. (Approximate position: Lat. 46° 56′ N, Long. 55° 21′ W).
Lawn: A semi-exposed rocky shore line with large boulders. The upper surface layers was warmer and less saline (15 o/oo and 18° C) than the lower layer (32.8 o/oo and 10° C). Visited on August 11, 1967. (Approximate position: Lat. 46° 56′ N, Long. 55° 32′ W).
Taylor Bay: A semi-exposed bay on the southern tip of the Burin Peninsula — just north of Point au Gaul. Visited August 17, 1948. (Approximate position: Lat. 46° 50′ N, Long. 55° 43′ W).
Lamoline: A semi-exposed shallow bay with scattered boulders. Surface water salinity 33.3 o/oo, temperature 17° C. Visited on August 11, 1967. (Approximate position: Lat. 46° 52′ N, Long. 55° 48′ W).
Lories: An exposed location on the southern tip of the Burin Peninsula; near Point May. Visited August 17, 1948. (Approximate position: Lat. 46° 51′ N, Long. 55° 55′ W).

Point Crewe: An exposed location approximately 3 miles west of Lories. Visited August 17, 1948. (Approximate position: Lat. 46° 52.5′ N, Long. 55° 58′ W).

Fortune Bay

Grand Bank: An exposed coastal area with substrate of large boulders and pebbles. Surface water salinity 33.2 o/oo, temperature 18° C. Visited August 11, 1967. (Approximate position: Lat. 47° 06′ N, Long. 55° 48′ W).

Garnish: An exposed coastal area with substrate grading from large outcrops to sand. Collection was made ½ mile south of the town. Visited August 11, 1948 and August 11, 1967. In August, 1967, the surface water salinity was 32 o/oo and the temperature 16° C. (Approximate position: Lat. 47° 14′ N, Long. 55° 22.2′ W).

Harbour Mille: A semi-exposed coastal area with steep cliffs. Bottom irregular and of large boulders. Surface water salinity 33 o/oo, temperature 19° C. Visited August 12, 1967. (Approximate position: Lat. 47° 35′ N, Long. 54° 56.5′ W).

Little Harbour East: A "V" shaped protected cove with a river flowing into it; approximately ½ mile south of Little Harbour East proper. A delta extends about ½ mile into the cove and it consists mostly of large pebbles. No large stones were present except along the sides. The surface water salinity at the head was brackish (18.2 o/oo) and it increased towards the mouth; temperature 20° C. Visited August 12, 1967. (Approximate position: Lat. 47° 35.5′ N, Long. 54° 50.8′ W).

Trinity Bay

Dildo: A sheltered beach located approximately ½ mile south of Dildo. Substrate of scattered boulders and pebbles which were covered with sediments. Visited August 15, 1967. (Approximate position: Lat. 47° 34′ N, Long. 52° 32′ W).

Spread Eagle: A sheltered beach located approximately 1 mile south of Spread Eagle. Substrate and topography similar to that at Dildo. Visited August 15, 1967. (Approximate position: Lat. 47° 32.5′ N, Long. 52° 35.5′ W).

Gull Cove: A semi-exposed cove on the east side of Trinity. Visited August 25, 1948. (Approximate position: Lat. 47° 48′ N, Long. 53° 31′ W).

Hant's Harbour: Collections were made on the exposed coastal side and the sheltered inner harbour side. The substrate on the exposed side ranged from large outcrops of rocks to scattered boulders, while scattered boulders and mud were present on the harbour side. The sublittoral area showed extensive grazing by sea urchins and also ice scouring. Surface water salinity 33.1 o/oo, temperature 12° C. Visited August 17, 1967. (Approximate location: Lat. 48° 01′ N, Long. 53° 16.5′ W).

Long Beach: Located on the South Arm of Random Sound. A semi-exposed location with scattered boulders in the littoral and sublittoral zones. Surface water salinity 33.8 o/oo, temperature 11° C. Visited August 18, 1967. (Approximate position: Lat. 48° 01′ N, Long. 53° 50.5′ W).

Adeyton: Located on the North West Arm of Random Sound. A sheltered beach with scattered boulders in the littoral and sublittoral zones. Visited August 18, 1967. (Approximate position: Lat. 48° 05′ N, Long. 53° 55′ W).

Shoal Harbour: A sheltered harbour with few scattered boulders in the littoral zone and a sand-mud bottom in the sublittoral. Surface water salinity 35.5 o/oo, temperature 13° C. Visited August 18, 1967. (Approximate position: Lat. 48° 12′ N, Long. 54° 00′ W).

Milton: Collection was made at a bridge which crosses the extreme northwest portion of Smith Sound. The area is a protected, shallow bay with occasional boulders on a mud flat. Visited August 18, 1967. (Approximate position: Lat. 48° 13′ N, Long. 53° 49.5′ W).

Conception Bay

Kelly's Island (a): An exposed coastal area on the south west corner of the Island. Substrate of large outcrops and scattered boulders. Visited August 16, 1967. (Approximate position: Lat. 47° 33′ N, Long. 53° 01′ W).

Kelly's Island (b): An exposed coastal area on the northwest side of the Island. Substrate and topography as at

station "a". The sublittoral area showed extensive grazing of sea urchins, and ice scouring was also evident. Much of the vegetation was restricted to cracks and crevices. Visited August 16, 1967. (Approximate position: Lat. 47° 33.3′ N, Long. 53° 00′ W).

Foxtrap: A semi-exposed coastal area with scattered boulders. Much of the substrate was denuded by ice action. Surface water salinity 31.6 o/oo, temperature 14.4° C. Visited August 16, 1967. (Approximate position: Lat. 47° 31′ N, Long. 52° 58′ W).

Bell Island: Collections were made on the southwest corner of the Island in a semi-protected cove area which had steep cliffs. The substrate ranged from large outcrops, boulders, pebbles to sand. Surface water temperature 15° C. Visited on August 16, 1967. (Approximate position: Lat. 47° 37′ N, Long. 53° 00.5′ W).

Carbonear Island: Collections were made on the east side of the Island in an exposed rocky beach. Substrate of large boulders. Surface water salinity 31.0 o/oo, temperature 8° C. Visited August 16, 1967. (Approximate position: Lat. 47° 41.5′ N, Long. 53° 12.5′ W).

Harbour Grace (a): A semi-exposed portion at the mouth of the harbour. Substrate of large rock outcrops and scattered boulders. The vegetation was heavily grazed by sea urchins. Visited August 16, 1967. (Approximate position: Lat. 47° 41.5′ N, Long. 53° 12.5′ W).

Harbour Grace (b) — Kings Beach: A sheltered beach southwest of station "a". Substrate of scattered boulders which were heavily covered with sediments. The water was very dirty in appearance. Visited August 16, 1967. (Approximate position: Lat. 47° 40.5′ N, Long. 53° 14′ W).

Harbour Grace (c): A sheltered beach in the town of Harbour Grace. Collections were made from the pier pilings. Surface water salinity 21.4 o/oo, temperature 6° C. Visited August 16, 1967. (Approximate position: Lat. 47° 41′ N, Long. 53° 13′ W).

Brigus Bay: An exposed coastal area with steep cliffs. Substrate of large massive outcrops of rocks grading into boul-

ders in the sublittoral zone. Surface water salinity 31.4 o/oo, temperature 12° C. Visited August 16, 1967. (Approximate position: Lat. 47° 31′ N, Long. 53° 13′ W).

Topsail Beach: A semi-exposed location east of Kelly's Island. Collections were made by Mr. Frank Martin on May 5, 1953. (Approximate position: Lat. 47° 32′ N, Long. 52° 56′ W).

Bacon Cove: A semi-exposed site south of Colliers Point. Visited on August 8, 1948. (Approximate position: Lat. 47° 25′ N, Long. 53° 13′ W).

Bonavista Bay

Lethbridge (a): A sheltered beach in Goose Bay. Substrate of scattered boulders in the littoral zone grading into a muddy sublittoral area. Surface water salinity 33.2 o/oo, temperature 20° C. Visited August 18, 1967. (Approximate position: Lat. 48° 22′ N, Long. 53° 49.5′ W).

Lethbridge (b): A sheltered beach 1 mile past Lethbridge on the road towards Brooklyn. Substrate and topography the same as station "a". Surface water salinity 30.8 o/oo, temperature 23° C. Visited August 18, 1967. (Approximate position: Lat. 48° 22′ N, Long. 53° 50.5′ W).

Lethbridge (c): A sheltered beach 2 miles past Lethbridge (north) on the road towards Brooklyn. Substrate, topography and vegetation as at stations "a" and "b". Surface water salinity 32.8 o/oo, temperature 20° C. Visited August 18, 1967. (Approximate position: Lat. 48° 23.7′ N, 53° 51′ W).

Lethbridge (d): A sheltered beach 3 miles past Lethbridge on the road towards Brooklyn. Substrate of fine gravel grading into scattered rocks and mud in the sublittoral zone. Visited August 18, 1967. (Approximate position: Lat. 48° 24.7′ N, Long. 53° 49.5′ W).

Sweet Bay: A sheltered location with large outcrops of rocks and scattered boulders. The vegetation was localized in cracks and crevices because of extreme ice action. Visited August 19, 1967. (Approximate position: Lat. 48° 27.2′ N, Long. 53° 38.1′ W).

Bloomfield: A sheltered beach in Goose Bay — 1 mile past

the post office. Substrate of scattered boulders grading into mud in the sublittoral zone. Surface water salinity 33.8 o/oo, temperature 15° C. Visited August 19, 1967. (Approximate position: Lat. 48° 23′ N, Long. 53° 54.9′ W).

Sir Charles Hamilton Sound

Gander Bay (a) — Mouth of Gander River and Gander Bay: A mud flat with abundant fresh-water runoff. Substrate of scattered boulders grading into mud in the sublittoral. Surface water salinity 22.7 o/oo, temperature 18° C. Visited August 20, 1967. (Approximate position: Lat. 49° 15.7′ N, Long. 54° 29.2′ W).

Gander Bay (b): A mud flat area 1.2 miles north of station "a". Substrate and topography the same as station "a". Surface water salinity 30.2 o/oo, temperature 20° C. Visited August 20, 1967. (Approximate position: Lat. 49° 15.8′ N, Long. 54° 28′ W).

Gander Bay (c): A mud flat area 4.1 miles north of station "a". Substrate and topography the same as at stations "a" and "b". Visited August 20, 1967. (Approximate position: Lat. 49° 20.4′ N, Long. 54° 21′ W).

Davidsville (a): A mud flat area with scattered boulders and a few pebbles. Opposite the post office in Davidsville. Collection was made from a pier piling at the location. Surface water salinity 23.5 o/oo, temperature 18° C. Visited August 20, 1967. (Approximate position: Lat. 49° 21′ N, 54° 21.5′ W).

Davidsville (b): A mud flat area with scattered rocks — 1.5 miles north of Davidsville. Visited August 20, 1967. (Approximate position: Lat. 49° 22.5′ N, Long. 54° 21′W).

Carmanville: A mud flat area with scattered rocks (opposite a general store), ½ mile before the ferry dock to Fogo Island. Visited August 20, 1967. (Approximate position: Lat. 49° 23′ N, Long. 54° 19′ W).

Noggin Cove: A sheltered cove with little vegetation present. Most of the substrate was mud, but occasional rocks were present. Surface water salinity 34.0 o/oo, temperature 21.5° C. Visited August 20, 1967. (Approximate position: Lat. 49/ 23′ N, Long. 54° 22′ W).

Notre Dame Bay

Lewisporte: A sheltered beach in Burnt Bay; with brackish water. Substrate of pebbles. Visited August 21, 1967. (Approximate position: Lat. 49° 15′ N, Long. 55° 04′ W).

Embree: A sheltered beach in Little Burnt Bay. Substrate of large boulders. A collection was made from a pier piling at the location and from the boulders. Surface water salinity 31.2 o/oo, temperature 18° C. Visited August 21, 1967. (Approximate position: Lat. 49° 18.5′ N, Long. 55° 01′ W).

Mason's Cove (a): A sheltered beach in Little Burnt Bay with large scattered boulders. Visited August 21, 1967. (Approximate position: Lat. 49° 19.5′ N, Long. 55° 01.2′ W).

Mason's Cove (b): A sheltered cove (approximately ¼ mile wide) three miles north of Mason's Cove. No name applied to it on the charts. Substrate of scattered rocks and mud. Visited August 21, 1967. (Approximate position: Lat. 49° 20.5′ N, Long. 55° 03′ W).

Big Cove: A sheltered cove at the end of the road in Little Burnt Bay. Substrate of scattered boulders. Visited August 21, 1967. (Approximate position: Lat. 49° 21′ N, Long. 55° 04′ W).

Brown's Arm: A mud flat area with brackish water. Substrate of scattered boulders and mud. Visited August 21, 1967. (Approximate position: Lat. 49° 16.2′ N, Long. 55° 08.5′ W).

Laurenceton: A sheltered beach in the Bay of Exploits. Substrate of small rocks. The area was comparatively barren of vegetation because of ice jams. Surface water salinity 34.8 o/oo, temperature 19° C. Visited August 21, 1967. (Approximate position: Lat. 49° 16.2′ N, Long. 55° 17′ W).

Bay of Islands

Humber Arm (a): A sheltered bay five miles out of Corner Brook. Substrate of small rocks grading into sand-mud in the sublittoral. Surface water salinity 25.1 o/oo, temperature 19° C. Visited August 23, 1967. (Approximate position: Lat. 48° 57.5′ N, Long. 57° 58′ W).

Humber Arm (b): A sheltered beach eight miles out of

Corner Brook. The substrate and topography are the same as at station "a". Visited August 23, 1967. (Approximate position: Lat. 48° 58.8′ N, Long. 57° 55.5′ W).

Benoit's Cove: A sheltered cove in Humber Arm. Substrate and topography the same as Humber Arm stations "a" and "b". A freshwater stream emptied into the cove. Visited August 23, 1967. (Approximate position: Lat. 49° 01′ N, Long. 58° 08′ W).

Frenchman's Cove (a): A sheltered cove with gravel substrate. Visited August 23, 1967. (Approximate position: Lat. 49° 03′ N, Long. 58° 12′ W).

Frenchman's Cove (b): A sheltered location approximately 8 miles west of Frenchman's Cove. Substrate of scattered rocks and pebbles. Visited August 23, 1967. (Approximate position: Lat. 49° 03′ N, Long. 58° 18′ W).

Cabot Strait

Margaree: An exposed rocky shore west of Port aux Basques. Substrate of large rock outcrop and scattered boulders. Visited August 24, 1967. (Approximate position: Lat. 47° 34.5′ N, 59° 04′ W).

Gulf of St. Lawrence

Bottle Cove: An exposed coastal beach. Substrate of sand and a few scattered boulders. Visited August 24, 1967. (Approximate position: Lat. 47° 42′ N, Long. 59° 15.5′ W).

Red Rock Point: An exposed coastal area with scattered boulders on a sandy beach. Visited August 24, 1967. (Approximate position: Lat. 47° 41.2′ N, Long. 59° 15′ W).

St. George's Bay

Stephenville Crossing: A sheltered beach of scattered boulders grading into sand-mud. Visited August 24, 1967. (Approximate position: Lat. 48° 31′ N, Long. 58° 28′ W).

Port au Port Bay

Boswarlos (a): A semi-exposed sandy beach with occasional rock outcrops. Located 1 mile before Boswarlos. Visited August 24, 1967. (Approximate position: Lat. 48° 35.3′ N, Long. 58° 49′ W).

Boswarlos (b): A semi-exposed sandy beach with the same topography and substratum as station "a". Visited August 24, 1967. (Approximate position: Lat. 48° 36′ N, Long. 58° 50′ W).

Winter House: An exposed open coastal beach south of the "Bar" on Port au Port Bay. Substrate of large scattered boulders and sand. Visited August 24, 1967. (Approximate position: Lat. 48° 42′ N, Long. 58° 48′ W).

Bonne Bay

Glenburnie: A sheltered location 1.1 miles past Glenburnie in the South Arm of Bonne Bay. Substrate of scattered boulders and mud. The transparency of the water was very good. Surface water salinity 32.8 o/oo, temperature 22° C. Visited August 25, 1967. (Approximate position: Lat. 49° 27′ N, Long. 57° 54′ W).

Woody Point: A sheltered location at the ferry dock at Woody Point — South Arm of Bonne Bay. Visited August 25, 1967. (Approximate position: Lat. 49° 30.5′ N, 57° 54.8′ W).

Discussion[1]

Of the 155 species of marine algae listed by us from a variety of coastal environments around Newfoundland 81 species appear to be new records for the Island. In addition Collins (1905) records 2 species which we have not seen

[1]A recent paper by Lee (Lee, R. K. S. 1968, "A collection of marine algae from Newfoundland I. Introduction and Phaeophyta". Nat. Canad. **95:** 957-978) has been published since our manuscript was submitted for publication. He records 26 species of brown algae from Newfoundland and the French islands of St. Pierre and Miquelon as well as 22 red and 16 green algae. Five of the brown algae were designated as new records (*Acrothrix novae-angliae, Desmarestia media, Punctaria plantaginea, Laminaria agardhii* and *L. groenlandica*). We have not seen the first two species, but record the last three. Although no distributional information is given on the red and green algae, one of the green (*Urospora mirabilis*) and four of the red algae (*Clathromorphum compactum, Euthora cristata, Ptilota pectinata* (?) and *Pantoneura baerii*) have not been recorded by us. According to our information a total of 185 species of marine algae is now known from Newfoundland.

(Porphyra linearis and *Calothrix scopulorum)*, while Taylor (1957) lists 14 *(Bolbocoleon piliferum, Cladophora expansa, Ulva lactuca, Alaria pylaii, Chorda tomentosa, Fucus miclonensis, F. spiralis, Laminaria longicruris, Bangia fuscopurpurea, Euthora cristata, Furcellaria fastigiata, Phymatolithon laevigatum, Rhodomela lycopodioides,* and *Rhodophyllis dichotoma)*, and Wilce (1959) lists 7 others *(Scytonema* sp., *Prasiola crispa, Laminariocolax tomentosoides, Leptonema fasiculatum, Dumontia incrassata, Peyssonnelia rosenvingii,* and *Phymatolithon lenormandi)*. At present a total of 178 species of benthonic marine algae are recorded from Newfoundland. Detailed seasonal investigations will no doubt add substantially to this number, for most collections have been restricted to the summer months and nothing is known of the winter-early spring vegetation.

A comparison of the marine flora of the nearby Islands of St. Pierre and Miquelon (Delamare, et al 1888; De la Pylaie, 1829; Hariot, 1889; Le Gallo, 1947, 1949; Taylor, 1957) indicates that seven other species *(Lyngbya aestuarii, Pleurocapsa kerneri, Cladophora albida, Antithamnion floccosum, Gracilaria verrucosa, Sorocarpus micromorus,* and *Omphalophyllum ulvaceum)* as well as the forma *scorpioides* of *Ascophyllum nodosum* are recorded for the vicinity of Newfoundland. Some of these will probably also be found in Newfoundland.

Of the red, brown and green algae reported by us 47% were recorded from the Labrador Peninsula (Wilce, 1959), 89% from the Canadian Maritime Provinces (Edelstein and McLachlan, 1966, 1967a, b; Edelstein, McLachlan and Craigie, 1967; MacFarlane and Milligan, 1965) and 50% from Jaffrey Point, New Hampshire (Mathieson, *et al*, in press). It is evident that there is a high degree of similarity between the floras in all of the areas. Of the 178 species recorded from Newfoundland only 3 do not extend south of the Island, 37 extend only to northern New England, 45 more stop in southern New England, while 46 reach New Jersey-Maryland, 6 North Carolina, 2 South Carolina and 39 reach to the tropics. Thus the marina flora of Newfound-

land is primarily subarctic in character, but it has a strong component of boreal and cosmopolitan species. In contrast, the marine flora of Labrador is primarily composed of arctic and subarctic components (Wilce, 1959) and it has a larger arctic element than Newfoundland. Several of the species recorded from Labrador are not known from Newfoundland or the Maritime Provinces. However, additional collections from the northern coasts of Newfoundland may show a somewhat larger arctic component.

A comparison of the number of species in the Maritime Provinces (Edelstein and McLachlan, 1966, 1967a, b; Edelstein, McLachlan and Craigie, 1967; MacFarlane and Milligan, 1965), Newfoundland and Labrador (Wilce, 1959) indicates that there is a reduction in the number of species farther north — i.e. as the winter conditions become more extreme. In fact, according to Wilce (1959), the arctic-subarctic floras of the north are primarily characterized by a lack of species and color diversity. Similarly fewer species are recorded from the northern than from the southern shores of Newfoundland. Although ice scouring is more rigorous in northern than southern Newfoundland, many of the southern locations show pronounced scouring. Extensive grazing bv sea urchins *(Strongylocentrotus drobachiensis)* is evident in the sublittoral zones (from 10 to at least 30 feet) of many exposed and semi-exposed open coasts. The combined effects of sea urchin grazing and ice scouring eliminate the bulk of the mid-sublittoral vegetation on the latter coasts. The residual flora in such areas consists mostly of crustose corallines, *Agarum cribrosum*, *Desmarestia* spp. and occasional small plants of other species in crevices.

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EDITH SCAMMAN: AN APPRECIATION

A squawky 'Maineac' voice, 'thistles' in the old straw hat, and always radiating from her warmest of hearts the kindness and generosity of human nature at its very best: that is how a loving but candid biographer might characterize Edith Scamman — straight from the heart in turn as she would have wished. For years we used to laugh affectionately together about these first two items — for instance how, when she was with us in England in the summer of 1939 at the declaration of war on Hitler's Reich, her rendering of 'Keep the Home Fires Burning' involved a sudden ascent to a high-pitched shriek each time for the 'Burning' and 'Yearning'; and how, the year before that, the already old straw hat had been stood upon by a pony in Iceland which would not get off it for all my urging and belaboring until several of the 'thistles' had been scattered to the wind. It was Edith herself who was on that stolid pony, and our thoughtful Icelandic hosts later explained that they had chosen it 'for the old lady' as the only one in the region which would not only never bolt but would not even budge when belabored! And there, prolonging our happy botanical wanderings and investigations of the plant life of the sites of the Viking farmsteads whence had come the early colonists of Greenland and the American mainland, we ran so short of cash that we could not even afford our accustomed weekly luxury of a copy of *The Saturday Evening Post*.

Yet there was also somewhere in Edith Scamman's make-up an indomitable spirit of enterprise and even adventure — which sent her many times to the wilds of Alaska and remote parts of Costa Rica and elsewhere, even in later life, in search of new plants for which she had a keen eye. Though one did not know, and did not want to know, her age, she must have been well on in her seventies before she ceased her often exacting botanical collecting trips alone in distant lands, and to the end she did not give up her work in the Gray Herbarium, though it was always difficult to persuade her to publish the results of it. Most aspects of her botanical labors have been well described by others (for

Plate 1406

Edith Scamman, in the Sierra de Talamanca of Costa Rica, April 1951.

example the Tryons in *Am. Fern J.* 58, pp. 1-4, 1968, who also give a useful 'Bibliography of Edith Scamman'). Yet to the taxa of vascular plants that they mention as named for her should be added at least *Cerastium scammaniae* Polunin (in *Rhodora* 53, p. 227, 1951), which she photographed and studied at my request in two of its few known stations overlooking Bering Straits. For although her chief interest everywhere was in the ferns, Miss Scamman's collecting in the North was far more general. Backing her steadfast enterprise, in spite of her relatively frail form and

eternal womanliness, were an almost tough persistence and the spirit of the frontiersman in which she evidently took after her pioneering, west-wandering father (who was once wounded in a real western hold-up, and participated as a banker in the California gold-rush in the early 1850s). Nevertheless, Edith delighted to relate how a forebear, a Colonel Scamman of nearby Biddeford, Maine, had been court-martialled (and acquitted) for going with his men to Bunker Hill, Maine, when ordered to the Battle of Bunker Hill!

Edith's father being many years older than her mother, she was left to care for the latter on his death and did so to the preclusion of the happiness of marriage which one would have wished for her. Perhaps in unconscious partial compensation, she lavished affection on her friends of all ages and situations and seemed always to revel in their news and correspondence. Yet the brave pioneer spirit had evidently been inherited from her venturesome father, so that after her mother's death, when already approaching her sixties, she began her serious study of plant life and to that end often adventurous travelling, 'tramping the countryside with a joy in living and with none of the fears that most of us who were her friends would have known' (according to the eulogy delivered at the Appleton Chapel, Harvard Yard, by the Reverend Dr. Frederick M. Meek on 4 December 1967). As a result of her inquisitiveness of mind and warmth of spirit she was beloved by children (including my own), and had several Alaskan and Indian babies named Edith after her; moreover to crown her pioneering there were friends who were anxious to see her admitted as the first woman member of that venerable bachelor establishment the New England Botanical Club — which now, only a little too late, has acceded to the inevitable march of time.

Botanically, Miss Scamman's observation and collecting were critical, painstaking, and often valuable — *inter alia* because of the out-of-the-way places which she was able to reach and, often, sojourn in. Notable among these were Eagle Summit in central Alaska and the interior of Costa

Rica where her headquarters in a dive named 'Bar Kentucky' might have been characterized by having 'cockroaches as big as rats and rats as big as cats'. As a result of her personal field activities, Harvard has benefitted particularly by some 5,000 sheets of vascular plants from various parts of Alaska and about 1,400 from Costa Rica representing some 500 species of ferns — almost all of her own collecting. Her botanical publications were few but reliable, and sometimes displayed a Wordsworthian quality that was, however, consistent with scientific accuracy.

Though well educated at Thornton Academy, Saco, and then at Wellesley and Radcliffe Colleges (at which latter she obtained an M.A. in English Literature in 1909), Edith Scamman was at heart a perpetual student, attending courses ranging from Systematic Botany and Ecology to Chinese at Harvard and elsewhere until almost her latest years; and she had an infectious quality of passing on her enthusiasms to a wide range of friends. It was in this course-taking connection that I first got to know her in the middle 1930s in the old Gray Herbarium situated in the erstwhile Harvard Botanical Garden which occupied the corner of Garden and Linnaean Streets, Cambridge. That was a happy place indeed to work — often practically through the night! There we were both devoted (if not wholly devout!) disciples of the late Professor Merritt L. Fernald, another Maine stalwart of undying memories, and I well recall how on one early occasion we made a field trip with his class for some days into northern New Hampshire and Vermont to observe the spring awakening of plant life in that delightful region. The trip was memorable in many ways, not the least of which was the faithfully chugging participation of Miss Scamman's already ancient brown Dodge car — which was still in the barn of her home in Saco, Maine, and even occasionally used, when we occupied her fine family house there some twenty years later. Her frugality was entirely for herself and by her nature: she had considerable property in California as well as in Maine, and to others was generosity personified. This is thought-

fully expressed in a wide range of legacies to friends and institutions.

Intensely religious in her early life, and active for many years on missionary boards, Edith Scamman become more and more convinced of the ultimate values of scientific truth and reasoning as a satisfactory basis for human life as her serious study of plants progressed through its third decade and into its fourth. The last time I went to Cambridge, Massachusets, to spend some days with her, in May of 1967, this philosophy seemed to prevail, though we did not discuss it specifically. She was already enfeebled, suddenly looking incredibly aged (she had seemed scarcely to change at all in the preceding thirty and more years), but still stubbornly refusing to move from the modest room in which she lived to more secure and comfortable quarters just across the street — affectionately arranged for by friends. And in spite of the setting up of a calling-system by which I would be brought over from Europe if I could be of any help, or at least in time to see her once again, this failed to function before she died in Cambridge on 4 November 1967, less than a month prior to her 85th birthday. It can truly be said, and I know I am reflecting the thoughts of numerous friends in many corners of the earth in saying so with deep feeling, that the world is not the same without Edith Scamman, having lost something rare and uniquely precious with her passing.

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ADDED NOTE ON EDITH SCAMMAN

When Edith Scamman first appeared at the old Gray Herbarium on Garden Street in Cambridge it was to take Professor Fernald's course. That was in the fall of 1935. I recall that he was somewhat disturbed that she was enrolled in the Radcliffe section. I was his teaching assistant and he muttered something about being on my guard about someone from Saco. Very soon he reversed his opinion when her unusual qualities of character, intelligence and generosity asserted themselves. It must have taken me longer, for in later years she often reminded me that I had, on one occasion, criticized her drawings in the laboratory, remarking something to the effect that "if you are interested it seems to me you should be able to do better work."

I went along on that memorable spring field trip mentioned above in Dr. Polunin's account. Unlike most of Professor Fernald's instructional excursions I recall that one more for the gathering of personalities than plants. That same spring Miss Scamman was planning her first botanical trip. In late May, before she left Cambridge, Dr. Lyman Smith and I, probably in my Model A Ford, drove out with her past Concord to some reasonably good roadside collecting area and gave her a lesson in the rudiments of scientific plant collecting.

In one other role I was privileged to play a part in Edith Scamman's career. This had to do with New England Botany. Under Professor Charles Weatherby's direction she had done a study of the ferns of New Hampshire. Both Mr. Weatherby and Miss Scamman had approached me about some possible source of publication. It was a bit of good fortune that being at that time Secretary of the New Hampshire Academy of Science, I could wield some influence in getting her "Ferns and Fern Allies of New Hampshire" published by that organization.

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NOTES ON THE FLORA OF COöS COUNTY, NEW HAMPSHIRE, III.

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Two collecting seasons have passed since the data covered in Note II (Rhodora 69: 29-34 (1967) were accumulated and the County continues to produce interesting material. Professor Pease cited 1689 taxa from the County in his Flora of Northern New Hampshire. There are now additional distributional data on over 750 of these taxa and more than fifty new taxa have been added. Most of the additions are adventive weeds, garden escapes or forms and hybrids. While one expects to find introduced plants on dumps, some of them have turned up in rather remote places. During World War II the fire tower on the summit of Signal Mountain in Millsfield was manned by a woman and she established a flower garden at the base of the tower; some of her plants still persist. When the Appalachian Mountain Club built their new MizpahHut on Mount Clinton they made the highest cultivated lawn in New Hampshire around the hut and a number of plants came in with the grass seed. But what is *Lysimachia punctata* doing in a gravel bank on Crystal Mountain at the end of a logging road up Four Mile Brook in Dix Grant nearly fifteen miles back in the woods?

In Note II I discussed the dilemma of the boundaries of Cutts Grant and hazarded the guess that the collections cited by Pease for this township and actually collected there could be counted on the fingers of one hand. It would only take three fingers; I have examined all the cited specimens in the herbarium of the New England Botanical Club, finding 101 of the 105 Pease citations. *Chimaphila umbellata*, var. *cisatlantica*, *Solidago squarrosa* and *S. Randii* were collected in the Grant; the localities given on the labels of all the other cited specimens indicate that they were collected in Sargent Purchase. During the summers of 1966 and 1967 I have made three trips into Cutts Grant up the Dry River Trail

and the Grant now has an authentic flora of some 140 taxa, but none of them are strictly mountain species.

During the past two summers I have also tried to improve the representation from the unorganized townships in the County. The known flora of Dix Grant has increased from five to 205 taxa and the Atkinson and Gilmanton Academy Grant from 17 to well over 200. Odell and Kilkenny are much better represented than formerly and Chandler Purchase has risen from zero to about 80. There are now not more than five townships represented by less than 100 taxa; all are in the southern half of the County. After another collecting season I hope there will be none. The year of collection is given in parentheses following the specimen citation.

Equisetum arvense L., var. *boreale* (Bong.) Ledeb. — Errol, *Harris* 30844 (67); Cambridge, *Harris* 30808 (67); Dummer, *Pease* 37553 (54); Kilkenny, *Harris* 31152 (67). Unreported in the Flora but the Dummer specimen in the herbarium of the New England Botanical Club had been so identified by Pease. Probably other County specimens identified as the species are this variety.

Osmunda cinnamomea L., forma *frondosa* (T. & G.) Britt. — Kilkenny, moist ground in Willard Notch, *Harris and W. Tiffney, Jr.* 30935 (67); Bean Grant, between Mizpah Hut and Mt. Jackson, *Harris* 29721 (66). Pease cites one collection from Randolph.

Pinus sylvestris L. — Milan, east side of the river, *Harris* 31380 (67). Spontaneous seedlings in a roadside plantation. The only other County collection was made by Deane in Shelburne.

Juniperus communis L., var. *depressa* Pursh. — Stark, roadbed of Grand Trunk Railway, Crystal, *Harris* 30487 (66); Berlin, roadside on east side of river, *Harris* 31387 (67). This seems to be a scarce plant in the County. Pease cites it from eight townships but the only other station I have seen is the cited specimen from Dummer which I found in an abandoned pasture on Dummer Hill in 1948; this colony was still doing well in 1967.

Sparganium androcladum (Engelm.) Morong — Milan, Long Pond, West Milan, *Harris* 30580 (66). Previously reported only from the Second (Dartmouth) College Grant.

Elodea Nuttallii (Planch.) St. John — Cambridge, Bog Brook, *Harris* 29864 (66). Now known from six townships; this species is probably more common than collections indicate.

Lolium perenne L. — Errol, roadside at Seven Islands, *Harris* 30997 (67); Bean Grant, lawn of Mizpah Hut, 3800 feet, *Harris* 29725 (66). Previously reported only from Randolph.

Lolium multiflorum Lam., var. *diminutum* Mutel — Pittsburg, town dump, *Harris* 31512 (67). Second record for the County; the first, from Millsfield, was reported in Note II.

Avena fatua L. — Pittsburg, about old stable near Moose Pond, *Harris and Scott* 30416 (66). New to the County. A few plants mixed in an abundant stand of *A. sativa* which was new to Pittsburg; *Harris and Scott* 31417 (66).

Sporobolus neglectus Nash — Dummer, Grand Trunk Railway tracks, *Harris* 30729 (66); Milan, Grand Trunk tracks near Copperville, *Harris* 30614 (66). The only previous record is from the adjoining town of Stark and also on the railway.

Calamagrostis Pickeringii Gray — Chandler Purchase, summit of Mount Pleasant, *Harris* 31766 (67). Previous collections are all from Sargent Purchase.

Alopecurus pratensis L. — Atkinson and Gilmanton Academy Grant, clearing at Hell Gate, *Harris* 30923 (67). The only other collections are from Lancaster and Shelburne.

Phalaris canariensis L. — Pittsburg, town dump, *Harris* 31513 (67); Errol, town dump, *Harris* 30132 (66); Milan, dump, West Milan, *Harris* 31282 (67). Two previous collections, also from waste ground.

Panicum dichotomiflorum Michx., var *geniculatum* (Wood) Fern. — Northumberland, waste ground, North Road, Groveton, *Harris* 30126 (66). The third record for the County.

Panicum miliaceum L. — Colebrook, town dump, *Harris* 30244 (66); Errol, town dump, *Harris* 30131 (66); Stratford, foot of Sugarloaf Trail, *Harris* 29738 (66); Milan, dump West Milan, *Harris* 29662 (66); Gorham, town dump Cascade, *Harris* 31463 (67). Three previous reports. The lookout on the Sugarloaf fire tower feeds birds.

Cyperus strigosus L. — Gorham, town dump Cascade, *Harris* 31468 (67). Pease cites the species from two towns on the Connecticut River where it may well be native but it is certainly an introduction on the Gorham dump.

Arisaema Stewardsonii Britt. — Atkinson and Gilmanton Academy Grant, low ground at Hell Gate, *Harris* 30880 (67). Reported from Colebrook as new to the County in Note II.

Lemna minor L. — Colebrook, roadside pool, *Harris* 30239 (66); Stark, farm pond, *Harris* 28796 (66). This brings the County representation to five townships; *Lemna* seems to be a difficult genus to find in northern New Hampshire.

Allium tricoccum Ait. — Milan, rich moist hillside, West Milan, *Harris* 28681 (66). Known from three other towns.

Cypripedium acaule Ait., forma *acaule* — Pittsburg, Indian Stream, *Chapman, Nugent, Nugent and Tiffney* (64); Stratford, road to Trio Ponds, *Harris* 28798 (66). See Note II for a discussion of the distribution of the pink-flowered form.

Epipactis Helleborine (L.) Crantz — Dixville, damp roadside near the Balsams, *Harris* 30223 (66). Previously known only from Mt. Prospect in Lancaster where it was first collected in 1943.

Salix discolor × *humilis* — Pittsburg, Indian Stream, *Chapman, Nugent and Tiffney* (64). First report for the County.

Salix gracilis, var. *textoris* × S. rigida — Pittsburg, Indian Stream, *Chapman, Nugent, Nugent and Tiffney* (64). First report for the County.

Populus alba L. — Stark, spontaneous seedling in dooryard, *Harris* 31376 (67); Milan, roadside on east side of river, *Harris* 31381 (67). Previously reported from two townships.

Ulmus rubra Muhl. — Dummer, road up Dummer Hill, *Harris* 29098 (66). I had been told at least ten years ago that in the 1800's *U. rubra* had been grown on Dummer Hill and the bark sold in Portland, Maine. At the time I had searched for remaining trees without success. While walking out from camp one morning in 1966 I noticed some samaras on the road which looked different from those of *U. americana*. They had fallen from two trees of *U. rubra* which overhang the road and which are at least eighteen inches in diameter at breast height. Both trees show evidence of Dutch Elm Disease but they again produced fruit in 1967. I can find no evidence of seedling trees in the vicinity.

Ulmus americana L., forma *pendula* (Ait.) Fern. — Cambridge, roadside, *Harris* 30815 (67). The second township for the County.

Ulmus americana, forma *laevior* Fern. — Pittsburg, Hall Stream, *Chapman, Nugent, Nugent and Tiffney* (64). The second report for the County.

Ulmus americana, forma *intercedens* Fern. — Atkinson and Gilmanton Academy Grant, vicinity of Hell Gate, *Harris* 30878 (67). New to the County. All four forms are now known from the County; of these forma *alba* (Ait.) Fern. is by far the most common.

Polygonum aviculare L., var. *vegetum* Ledeb. — Dummer, waste ground Paris, *Harris* 29905 (66); Milan, Emery farm West Milan, *Harris* 27394 (65). Previously known from the railroad in Gorham.

Polygonum Persicaria L., forma *albiflorum* Millsp. — Atkinson and Gilmanton Academy Grant, roadside, *Harris* 30002 (66). First report for the County.

Polygonum Persicaria, var. *ruderale* (Salisb.) Meisn. — Gorham, town dump Cascade, *Harris* 31470 (67). New to the County.

Chenopodium urbicum L. — Pittsburg, roadside Indian Stream, *Harris and Scott* 30418 (66). The third record for the County.

Lychnis Flos-cuculi L. — Pittsburg, logging road east of Parmacheene Bog, *Harris and Scott* 29150 (66). First reported for the County in Note II. In June 1966 a lady in Berlin told me she had found Ragged Robin "on the right side of the road somewhere between Dixville Notch and Pittsburg." I promptly searched that stretch of

road, a matter of some thirty miles, without success. Knowing that she had found it on her way to go birding with Fred Scott, I looked him up to see if she had shown him the plant and told him where she found it. He had never heard of Ragged Robin and I showed him the picture in his old Reed Flower Guide. In less than a week he sent me a fragment of the species which he had discovered in the locality cited above. Thus there are now two definite stations for the species in the County plus a third yet to be relocated.

Ranunculus trichophyllus Chaix, var. *trichophyllus* — Cambridge, Bog Brook, *Harris* 29845 (66). The sixth township for the County.

Ranunculus repens L. — Pittsburg, logging road east of Parmacheene Bog, *Harris and Scott* 29125 (66); Randolph, roadside Keenan Brook, *Harris and W. Tiffney, Jr.* 30925 (67). This introduced species is now known from four townships. With the exception of the Pease collection made on the Ravine House lawn in Randolph, all collections have been made on logging roads well off the beaten path.

Aconitum Napellus L. — Dummer, cellar hole Dummer Hill, *Harris* 27580 (65). The old farm where this still persists was abandoned at least fifty years ago.

Sanguinaria canadensis L. — Atkinson and Gilmanton Academy Grant, low ground at Hell Gate, *Harris* 30874 (67). The other four townships from which this species is known are all on the Connecticut River; the Academy Grant is in the Androscoggin watershed.

Fumaria officinalis L. — Milan, Emery farm West Milan, *Harris* 29541 (66). The second report for the County. This species has appeared as a weed in a vegetable garden for at least twenty years; I did not find it again in 1967.

Raphanus Raphanistrum L., forma *albus* (Scheubler & Martens) Hayek — Berlin, site of old dump Jerico, *Harris* 27870 (65); Gorham, town dump Cascade, *Harris* 31466 (67). One other report from the County.

Sedum spurium Bieb. — Milan, dump West Milan, *Harris* 29678 (66). New to the County.

Saxifraga cernua L.

Saxifraga Aizoön Jacq. — Both of these Saxifrages are new to New Hampshire. They were found on Mount Washington in 1939 by Dr. John A. Churchill; the station was relocated in 1967. For full details see Rhodora **69:** 483-486 (1967). These are the most exciting finds made in the County for several decades.

Potentilla canadensis L. — Pittsburg, Indian Stream, *Chapman, Nugent, Nugent and Tiffney* (64). The first collection for the County.

Lupinus polyphyllus Lindl. — Millsfield, summit of Signal Mountain, *Harris* 31356 (67). Persistent in old garden at base of fire tower. Third collection for the County.

Trifolium repens L., forma *phyllanthum* (Sm.) Fieri & Beguinet — Milan, roadside West Milan, *Harris* 29171 (66). New to the County.

Lotus corniculatus L. — Stark, roadside, *Harris* 30971 (67); Northumberland, roadside Groveton, *Harris* 30972 (67). I reported this as new to the County in 1965, Rhodora **67**: 196; it is now known from six townships.

Rhus typhina L. — Errol, roadside, *Harris* 30837 (67); Milan, field near Cedar Pond, *Harris* 31166 (67). The Errol station extends the known range of the species in the Androscoggin valley north by some thirty miles.

Vitis vinifera L. — Milan, dump West Milan, *Harris* 31271 (67). New to the County. I was interested to find that seedlings of a table grape which I assume to be this species occur on dumps in northern New Hampshire just as they do on dumps in Essex County, Massachusetts. They apparently are not hardy enough to withstand New England winters.

Malva moschata L., forma *moschata* — Pittsburg, town dump, *Harris* 28979 (66); Second College Grant, site of old farm, *Harris* 31338 (67). Both collections seem to be the typical form which is unreported for the County. There are numerous collections of forma *laciniata* and some of forma *heterophylla*, however.

Althaea rosea Cav. — Milan, dump West Milan, *Harris* 29681 (66). This is another fairly regular inhabitant of dumps. Not reported previously from the County.

Abutilon Theophrasti Medic. — Pittsburg, site of Depot Camp, Indian Stream, *Harris and Scott* 30422 (66). Another first collection for the County.

Viola arvensis Murr. — Stark, dooryard Crystal, *Harris* 31139 (67). The third township for the County.

Lythrum Salicaria L. — Dummer, waste ground Paris, *Harris* 29894 (66); Whitefield, roadside ditch, *Harris* 29173 (66). As yet this is not a common weed in the County there being only two previous collections. It would not be surprising if Pittsburg should be the next town where it is reported since I have collected it in Quebec not more than a hundred yards over the border above Third Lake.

Epilobium coloratum Biehler — Second College Grant, along Swift Diamond, *Harris* 30050 (66); Stratford, roadside along Nash Stream, *Harris* 30099 (66). The only other collection was made in Whitefield in 1897.

Panax trifolium L. — Pittsburg, Hall Stream, *Chapman, Nugent, Nugent and Tiffney* (64). There are only three other towns represented. Possibly this species is more abundant than collections indicate because the flowering period is over in early June before most botanists start collecting in the County.

Moneses uniflora (L.) Gray — Dixville, shore of Mud Pond, *Harris* 30205 (66); Cambridge, shore of Bog Brook, *Harris* 29823 (66); Cutts Grant, between Shelter #2 and Mizpah Hut, *C. C. Harris* 29720 (66). Pease cites three towns for this species; this brings the total to six.

Gaultheria procumbens L., forma *suborbiculata* Fern. — Stratford, summit North Percy Peak, *C. C. Harris* 30483 (66). The second collection for the County.

Lysimachia punctata L. — Dix Grant, gravel bank at end of road up Four Mile Brook, *Harris* 30445 (66), 31061 (67). New to the County. An odd place to find a garden escape since there is no evidence that there ever had been a garden within miles of the spot.

Convolvulus arvensis L. — Milan, tracks of Grand Trunk Railway near Copperville, *Harris* 30604 (66). First report for the County.

Myosotis sylvatica Hoffm. — Pittsburgh, Hall Stream, *Chapman, Nugent, Nugent and Tiffney* (64). The second report for the County.

Dracocephalum parviflorum Nutt. — Bean Grant, edge of lawn at Mizpah Hut, *Harris* 29730 (66). New to the County. The station was still extant in 1967.

Lamium maculatum L., forma *lacteum* (Wallr.) G. Beck — Millsfield, summit of Signal Mountain, *Harris* 31355 (67). New to the County.

Monarda media Willd. — Dummer, beside old cellar hole Dummer Hill, *Harris* 29693 (66). New to the County. This long abandoned farm once had an herb garden. Professor Pease collected *Asarum canadense* here in 1930 and it is now abundant for a hundred yards along the road; I am sure the *Asarum* came from the herb garden rather than being native to Dummer Hill.

Solanum sarachoides Sendtner — Gorham, town dump Cascade, *Harris* 31465 (67). New to the County. This weed is still not common in New England but seems to be spreading in the area.

Euphrasia canadensis Townsend — Dix Grant, road up Four Mile Brook, *Harris* 30461 (66); Wentworth Location, road to Dixie Dam, *Harris* 30441 (66); Dixville, roadside near the Balsams, *Harris* 30211 (66); Colebrook, roadside, *Harris* 30240 (66); Millsfield, logging road, *Harris* 31366 (67); Dummer, road to Dummer Pond, *Harris* 30352 (66). Pease cites five towns and describes the species as local. In the northern half of the County it appears to be fairly common and has distinctly weedy characteristics. Mr. Leo Charette has recently pointed out that the two collections of Forbes cited from Green Grant are *E. americana* rather than *E. canadensis* and I am sure that other collections cited by Pease and by me could well be referred to *E. americana* or some other related species. Specific lines in this confusing genus are not clearly drawn and until the genus has had a thorough revision it seems to me that it is best to treat collections as a single highly variable species.

Rhinanthus Crista-galli L. — Atkinson and Gilmanton Academy Grant, roadside, *Harris* 30248 (66); Clarksville, road to Clarksville Pond, *Harris* 29014 (66); Second College Grant, road along the Swift Diamond, *Harris* 30081 (66); Wentworth Location, field, *Harris* 28915 (66); Errol, roadside, *Harris* 28953 (66). Pease knew this

species only from Pittsburg where he first found it in 1938. In Note II I reported it from the northern edge of Randolph. Apparently in the northern half of the County it is now a rapidly spreading weed.

Galium erectum Huds. — New to the County. The Pease collection #30134 (43) cited from Whitefield under *G. Mollugo* is a perfectly good specimen of this rather dubious species.

Cephalanthus occidentalis L. — Milan, Long Pond, *Harris* 30549 (66), North Branch, *Harris* 30588 (66). It seems strange that Buttonbush is a rare plant in Coos County. Pease collected it in Northumberland in 1909 and Deane found a single bush in a hen yard in Shelburne and traced its history over a number of years in Rhodora. In August 1966 a lady in West Milan showed me a flowering head which was in a bouquet her grandson had brought her from a pickerel fishing trip. His mother told me that he had fished in Long Pond, so I put my boat in there and found a few sterile bushes. A few days later the boy told me he had fished the North Branch and again by boat I found abundant flowering material there.

While searching in Long Pond I also found *Xyris montana* which is cited in Pease only from Pike Pond in Stark and Goose Pond in Milan. Goose Pond appears as a locality in Milan on a number of Pease's collections. This poses a problem. I have been unable to find Goose Pond, Milan, on any map and I have asked numerous inhabitants of Milan who have lived there all their lives and none have ever heard of it. Since Pease also cites specimens from Long Pond, Goose Pond is not apparently a synonym for that.

Eupatorium rugosum Houtt., forma *villicaule* Fern. — Pinkham Grant, Glen Road, *Floyd* (03); cited in Pease as *E. rugosum*. New to the County.

Aster puniceus L., forma *albiflorus* (Farw.) Shinners — Dixville, logging road near Mud Pond, *Harris* 30181 (66); Odell, between Little Bog Pond and Trio Ponds, *Harris* 30515 (66). This doubles the representation of this taxon in the County.

Aster junciformis Rydb. — Dalton, *Pease* 39316 (58). The second collection from the County.

Aster nemoralis Ait., forma *albiflorus* Fern. — Milan, Long Pond, *Harris* 30564 (66). Long Pond is on the outlet of South Pond in Stark where Pease made the only other collection of this taxon in the County.

Gnaphalium sylvaticum L. — Dix Grant, along the Swift Diamond, *Harris* 29559 (66); Dixville, logging road near Mud Pond, *Harris* 30142 (66); Erving Location, logging road, *Harris* 28181 (65); Columbia, roadside Cilley Hill, *Harris* 28309 (65); Odell, Trio Pond road, *Harris* 30508 (66); Dummer, road to Dummer Ponds, *Harris* 30354 (66). First collected in Success in 1908 and not found again until 1942. The species is frequent now in the northern half of the County.

Ambrosia trifida L. — Berlin, waste ground Mechanic Street, *Harris* 27959 (65). There are only two other collections from the County. I first saw the plant in Berlin in the early 1950's and told Pease but at the time it was not convenient to collect a specimen. On visiting the same site in 1965 I was surprised to discover that the species had persisted more than ten years and pleased to be able to validate the report in Pease with a specimen.

Helianthus laetiflorus Pers. — Dummer, Grand Trunk Railway, *Harris* 30733 (66). The third town for the County.

Helianthus tuberosus L. — Errol, town dump, *Harris* 31505 (67). Known from three other towns.

Helenium nudiflorum Nutt. — Milan, schoolyard West Milan, *Harris* 30438 (66). The fourth town for the County.

Calendula officinalis L. — Milan, dump West Milan, *Harris* 29685 (66). The second collection for the County.

Centaurea montana L. — Dummer, lawn at our camp on Dummer Hill, *Harris* 27407 (65). Two other collections from the County. This species was planted in our flower garden nearly twenty years ago. There are now dozens of clumps of it on the lawn and the surrounding field.

Crepis capillaris (L.) Wallr. — Dixville, logging road near Mud Pond, *Harris* 30185 (66). The third town for the County. I collected it again in Dixville in 1967 on a logging road several miles from the cited location.

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ADDITIONS TO THE KANSAS FLORA

Field studies undertaken during a floristic survey of Cowley County, Kansas, have resulted in the collection of two taxa previously unreported for the state. They are listed below.

The specimens cited in this note may be found in the Herbarium of Oklahoma State University. Special thanks are due to Dr. U. T. Waterfall for his help and encouragement during the study.

Ipomoea Shumardiana (Torr.) Shinners. Shinners (1961) made the above combination which replaced *I. Careltoni* Holz. This taxon, originally described as a Texas-Oklahoma endemic, can be separated from *I. longifolia* Holz. by its ovate-lanceolate leaf-blades widest near the base, and its smaller calyces. It differs from *I. pandurata* (L.) G. Meyer in leaf characters. The collections *(Koch 1707* and *1530)* are from an abandoned field and adjacent railroad right-of-way one half mile north of Winfield and extend the known range of the species eighty miles north from Payne County, Oklahoma.

Melothria pendula L. The first collection *(Koch 1989)* was made from the shade of a stand of *Populus deltoides* Marsh. along the Arkansas River northeast of Arkansas City. The following summer it was taken from the margin of a small stream near Gueda Springs *(Koch 4077)* where it was partially shaded by the dense growth of *Ambrosia trifida* L. These collections extend its known range some one hundred miles north and west of previously reported sites in Oklahoma (Waterfall, 1966) and Missouri (Steyermark, 1963).

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Rhodora

JOURNAL OF THE

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Vol. 71 April-June No. 786

CONTRIBUTION TO THE FUNGUS FLORA OF NORTHEASTERN NORTH AMERICA. V.[1]

HOWARD E. BIGELOW AND MARGARET E. BARR[2]

Since our last report on the higher fungi of the northeast, continued field work and the laboratory study of specimens have resulted in additional records of fruiting as well as the discovery of more new species. Some interesting variations of well known species have been found also. The following constitute a miscellaneous assemblage which does not belong to monographic work currently in progress.

As previously, the data on agarics are from the studies of the senior author, while the junior author has contributed the information on ascomycetes. The colors mentioned within quotation marks are from Ridgway, R. 1912. Color Standards and Color Nomenclature. Washington, D.C. Unless stated otherwise, the collections cited are deposited in the Herbarium of the University of Massachusetts, Amherst (MASS).

BASIDIOMYCETES

Armillaria decorosa (Pk.) Smith & Walters, Mycologia **39:** 622. 1947.

Material examined. **Vermont:** *Bigelow* 13940, Bingham Falls, near Stowe, Lamoille Co., 9 Sept 1964. Solitary or scattered, on hardwood log.

---

[1]I. Rhodora **62:** 186-198. 1960. II. Rhodora **64:** 126-137. 1962. III. Rhodora **65:** 289-309. 1963. IV. Rhodora **68:** 175-191. 1966. Contribution from the Department of Botany, University of Massachusetts, Amherst.

[2]Mrs. Howard E. Bigelow.

This rare species is described and illustrated by Smith and Walters (1947), and by Farlow and Burt (1929, as a *Tricholoma*). The following provides additional information on microscopic characters.

Spores 5-6 × 3-3.5 μ, elliptic, smooth, amyloid. Basidia 15.5-21 × 5.5-6 μ, 4-spored. Cystidia not differentiated. Pileus cutis brown in KOH, pigment in cell contents and in thickened smooth walls, hyphae cylindric or composed of chains of ± sausage-shaped cells, 5.5-19 μ in diameter, 31-55 μ long, trama pale brown in KOH, hyphae cylindric to inflated, 4-11.5 μ in diameter, walls thin or slightly thickened, hyaline or faintly brown. Hymenophoral trama regular to subparallel, hyaline in KOH, hyphae cylindric or slightly inflated, 4-9 μ in diameter. Clamp connections present.

As Smith and Walters have indicated, *A. decorosa* seems closely related to the lignicolous species of *Cystoderma*. I did not find the sphaerocysts typical of *Cystoderma* in the Vermont carpophores, but certainly the sausage-shaped cells of the cuticular sphaerocysts.

Armillaria viscidipes Peck, New York State Mus. Rep. **44**: 16. 1891. Plate 1406.

Pileus 6.5-13.5 cm broad, broadly convex to plane, broadly subumbonate at times, margin incurved at first, finally upturned in age, even, surface dry when collected but probably viscid in wet weather, somewhat shining, innately fibrillose in places or diffracted scaly, in age cracked or pitted at times, color a sordid buff; context thick, white, tough, odor pungent, taste mild.

Lamellae adnexed at first becoming rounded or slightly sinuate, narrow to moderately broad (up to 1 cm), close or crowded, forked at times, whitish becoming cream-colored, dingy in age, edges even, slightly undulate.

Stipe 5-11 cm long, apex 1.5-3.4 cm thick, equal or base ventricose (up to 4 cm thick), abruptly tapered in substrate, solid (white within and continuous with pileus flesh), apex white, fibrillose to somewhat scabrous (about ¼ of stipe length), partial veil thin and soon collapsed, central portion and base viscid, brownish stained when gluten dried, rather shiny and somewhat zoned or appressed scaly.

Spores 6-8 × 4-5.5 μ, elliptic to broadly elliptic, smooth, not amyloid, spore deposit white. Basidia 31-44 × 6-8 μ, 4-spored. Cystidia not differentiated. Pileus surface with very thin gelatinous pellicle, cutis thin, hyphae mostly cylindric, (2-)4-12.5 μ in diameter; tramal hyphae cylindric to inflated, 7.5-18.5(-21.5) μ in diameter, walls often somewhat thickened. Hymenophoral trama of subparallel hyphae, slightly

Plate 1406

Plate 1406. *Armillaria viscidipes* Peck. × 1.

diverging near subhymenium, hyphae cylindric, 2.5-5(-8.5) μ in diameter. Clamp connections absent. Refractive hyphae present but rare.

Gregarious, on mossy hummock near stream through open hemlock stand.

Material examined. **Massachusetts:** *Bigelow* 14999, Conway, Franklin Co., 31 Oct 1966; 15590, same locality, 16 Oct 1968.

This *Armillaria* also appears to be rare according to the records in the literature. Besides the orginal description based on specimens found in New York, the only other

records from the east appear to be those of Hesler (1945). He collected *A. viscidipes* in Kentucky and Tennessee. Kauffman (1921, 1925) has reported fruitings in Colorado and Oregon.

Cystoderma amianthinum var. **sublongisporum** Singer, Pap. Mich. Acad. Sci., Arts, Lett. **30:** 112. 1945.

Material examined. **Massachusetts:** *Bigelow* 7883, Mt. Toby, Sunderland, Franklin Co., 4 Oct 1958; 7963, same locality, 2 Nov 1958; 10035, Womens Club State Forest, New Salem, Franklin Co., 7 Nov 1961. **New Hampshire:** 12519, Oliverian Brook trail, White Mountains Nat. Forest, 7 Sept 1963. **Vermont:** 13673, top of Mt. Mansfield, 29 Aug 1964; 13812, 13813, Ranch Brook trail, near Stowe, Lamoille Co., 1 Sept 1964; 13941, Bingham Falls, near Stowe, 9 Sept 1964; 14011, same locality, 11 Sept 1964; 14360, same locality, 3 Oct 1964. **Quebec:** 4783, 4784, 4785, Provincial Nursery, near Berthierville, 9 Oct 1956; 4861, near Farnham, 28 Oct 1956; 4871, Provincial Nursery, 30 Oct 1956; 6124, Lac Cascapédia, Gaspé Parc, 21 Aug 1957.

Usually scattered or gregarious on mossy conifer logs, occasionally solitary on ground under conifers.

Although not quite as common in the northeast as var. *amianthinum*, var. *sublongisporum* is widespread and often encountered. The spore size of specimens must be determined to separate the two varieties unless var. *amianthinum* f. *rugosoreticulum* is involved. The latter can be distinguished in the field by the rugose cap and often a green corn odor when the flesh is crushed.

Cystoderma pulveraceum (Pk.) Smith & Singer, Pap. Mich. Acad. Sci., Arts, Lett. **30:** 104. 1945.

Material examined. **Vermont:** *Bigelow* 9819, near Whitingham, Windham Co., 10 Sept 1961.

Solitary, on moss covered very decayed log under conifers.

Hygrophorus conicus (Fr.) Fr. Epicrisis, p. 331. 1838. *form*. Plate 1407.

Pileus 1.8-5.5 cm broad, conic at first then the margin spreading, umbo prominent and blunt, surface moist, radiate-fibrillose at first, often becoming squamulose, fibrils and scales black, ground color deep red at first, paler in age to reddish-orange then finally orange, ground color of expanded pilei obscured by black of scales except on the margin; context thin, firm but brittle, watery dingy citrine fading to whitish, finally black, no odor and taste.

Plate 1407

Plate 1407. *Hygrophorus conicus* (Fr.) Fr. *form.* × 1.

Lamellae adnexed to free, close to subdistant, broad (up to 9 mm), ventricose or rounded near pileus margin, narrowest at the stipe, faces pale yellow at first, becoming sordid and darker yellow, finally reddish and with a bloom near the pileus margin, edges whitish at first, red marginate at times, blackening, uneven.

Stipe 3.5-8 cm long, 5-9 mm thick, equal or the base enlarged (up to 14 mm), hollow (interior blackening when cut), surface fibrillose striate, fibrils black over a greenish yellow ground color, often with a reddish blush in part or over the whole length.

Spores 10-12 × 5.5-7 μ, elliptic to obovate or oblong, slightly bent at times, smooth, olive black at times in KOH, not amyloid. Basidia

31.5-46 × 7-8.5 μ, 4-spored, often olive-blackish in KOH, blackness in contents, granular or diffuse. Cheilocystidia present on some gills, clavate to rostrate or mucronate, 30-60 μ long, 9-13 μ in diameter, agglutinated and blackened at times. Pleurocystidia not found. Pileus cutis dark olive black in KOH, pigment in contents — spotted or homogeneous, wall thickened at times, hyphae cylindric or somewhat inflated, 1.5-11 μ in diameter, trama olivaceous-yellow in KOH, appearing cellular at times, hyphae inflated, 15-19 μ in diameter, walls somewhat thickened. Hymenophoral trama parallel, hyphae cylindric to somewhat inflated, 4-17 μ in diameter. Clamp connections present. Refractive hyphae present.

Gregarious, on humus under hardwoods.

Material examined. **Vermont:** *Bigelow* 12998, Bingham Falls, near Stowe, Lamoille Co., 22 July 1964; 13032, Stowe, 23 July 1964; 13243, Bingham Falls, 3 Aug 1964.

With the black squamules over bright pileus colors, the red gills, and red blush on the stipe, this interesting variation of *H. conicus* is striking in the field. Typical specimens were found in the same general locality about the same time and weather conditions did not appear to be responsible for the different appearance. Comparison has been made with *H. conicoides* Orton, which also has red pigments, but the spores of the Vermont collections are identical with those of typical *H. conicus* and not elongate as in *H. conicoides*.

As far as I have been able to determine, cheilocystidia have not been reported for *H. conicus* before. These are difficult to identify in young lamellae, but are quite abundant in expanded ones. The red color leaches out of sections readily in KOH, but is obscured by other pigments if blackening has occurred.

Hygrophorus cossus Fr., Epicrisis p. 321. 1838.

Material examined. **Massachusetts:** *Bigelow* 15373, Conway State Forest, Franklin Co., 10 Oct 1967.

Gregarious, under hardwoods.

Hygrophorus fibrillosus Bigelow, *sp. nov.* Plate 1408.

Pileus 1.5-2.3 cm latus, convexus, margine decurvatus et incurvatus, siccus, opacus, fibrillosus, pallido-bubolinus; caro albida, crassa, solida, odore et sapore farinaceo. Lamellae decurrentes, confertae, angustae, incrassatae, subvinoso-griseae. Stipes 2.5-4.2 cm longus, 6-9 mm crassus, aequalis vel deorsum attenuatus, solidus, siccus,

Plate 1408

Plate 1408. *Hygrophorus fibrillosus* Bigelow, sp. nov. × 2.

opacus, velutinus, pileus concolorus. Sporae (6-)7.5-9(-10) × (3-)3.5-4.5 μ, ellipticae vel oblongae vel subcylindricae, levi, amyloideis. Cheilocystidia 22-30 × 3-6 μ. Hyphis fibulatis.

Typum legit **H. E. Bigeloy**, n. 13331, Monroe State Park, Washington Co., Vermont, 6 Aug 1964, in Herb. Univ. Mass. conservatum.

Pileus 1.5-2.3 cm broad, convex with a strongly incurved and inrolled margin, surface dry and dull, heavily matted fibrillose under a lens, dingy pale buff colored (dingy "light buff"); context thick, dingy whitish, firm, odor and taste farinaceous; KOH — reddish brown.

Lamellae adnate, close, narrow, thickened, forked at times, gray ("pale drab gray"), edges even.

Stipe 2.5-4.2 cm long, 6-9 mm thick at apex, equal or tapering downward, solid (dingy whitish within), slightly curved at times, central, surface dry and dull, velvety under a lens, concolorous with pileus.

Spores (6-)7.5-9(-10) × (3-)3.5-4.5 μ, elliptic to oblong or rarely subcylindric, smooth, amyloid. Basidia 32-45 × 6-8 μ, 2- and 4-spored. Cheilocystidia cylindric or nearly so, 22-30 μ long, 3-6 μ thick, smooth, hyaline, flexuous at times, forked or irregular at times. Pleurocystidia not found. Pileus cutis an interwoven mass of cystidioid end cells, cylindric to subclavate, sometimes broadly fusoid or irregular, 4.5-11.5 μ in diameter, cells 24-70 μ long, brownish in KOH, pigment dilute in cell contents and in smooth thin walls, trama of similar hyphae only compact. Hymenophoral trama subregular but slightly divergent near the subhymenium, brownish in KOH, hyphae cylindric, 3-6 μ in diameter. Clamp connections present.

Gregarious, on soil and humus under birch and maple. August.

Material examined. **Vermont:** *Bigelow* 13331 (type), Monroe State Park, Washington Co., 6 Aug 1964.

All parts of the fresh carpophore show a color change to reddish or reddish brown when touched with drops of 3% KOH, but this is a curious reaction as the color is only at the edges of the drop. When revived sections of the cap and gills are mounted in KOH for microscopic study, the gills turn reddish promptly but soon fade out to pallid or yellowish. In addition, the cap and stipe darken overall to a light gray in drying.

By the amyloid spores and KOH reaction on the fresh carpophore *Hygrophorus fibrillosus* would seem close to *H. angelesianus* Sm. & Hesl., but the latter is distinctive by broader spores (4-5.5 μ), no cystidia, a viscid pileus, and dark sordid gray to grayish brown colors in pileus and stipe. The species of *Dermoloma* with amyloid spores as well as *Tricholoma griseum* Dennis and *Tricholoma hygrophorus* Joss. nom. nud. were also compared to *H. fibrillosus*, but none of these have the same diagnostic characters. *Tricholoma hygrophorus* is perhaps the nearest to *H. fibrillosus* but differs principally by the broad and distant lamellae and spores 5.9-6.5(-7) × 4.5-5.2 μ.

Hygrophorus marginatus var. **concolor** Smith, Pap. Mich. Acad. Sci., Arts, Lett. **38**: 59. 1953.

Material examined. **Maine:** *Bigelow* 11258, Cedar Lake, T3R9,

Penobscot Co., 24 Aug 1962. **Massachusetts:** 9714, Hawley Bog, Franklin Co., 10 Aug 1961. **New Hampshire:** 12257, Pinkham Notch, White Mountains Nat. Forest, 15 Aug 1963. **Rhode Island:** 14406, Beach Pond State Park, Exeter Co., 22 July 1965. **Vermont:** 13084, Ranch Brook, near Stowe, Lamoille Co., 27 July 1964; 13223, Bingham Falls, near Stowe, Lamoille Co., 3 Aug 1964.

Hygrophorus marginatus var. **olivaceus** Smith & Hesler, Lloydia **5:** 40. 1942.

Material examined. **Maine:** *Bigelow* 10997, Abol Field near Baxter State Park, Piscataquis Co., 14 Aug 1962; 11331, Upper Togue Pond, Piscataquis Co., 27 Aug 1962; **New Hampshire:** 11870, Sawyer Rock, White Mountains Nat. Forest, 20 July 1963. **Vermont:** 12922, Lake Mansfield, Lamoille Co., 20 July 1964; 13408, Morristown, Lamoille Co., 12 Aug 1964.

Hygrophorus recurvatus Peck, New York St. Mus. Bull. **157:** 28. 1912.

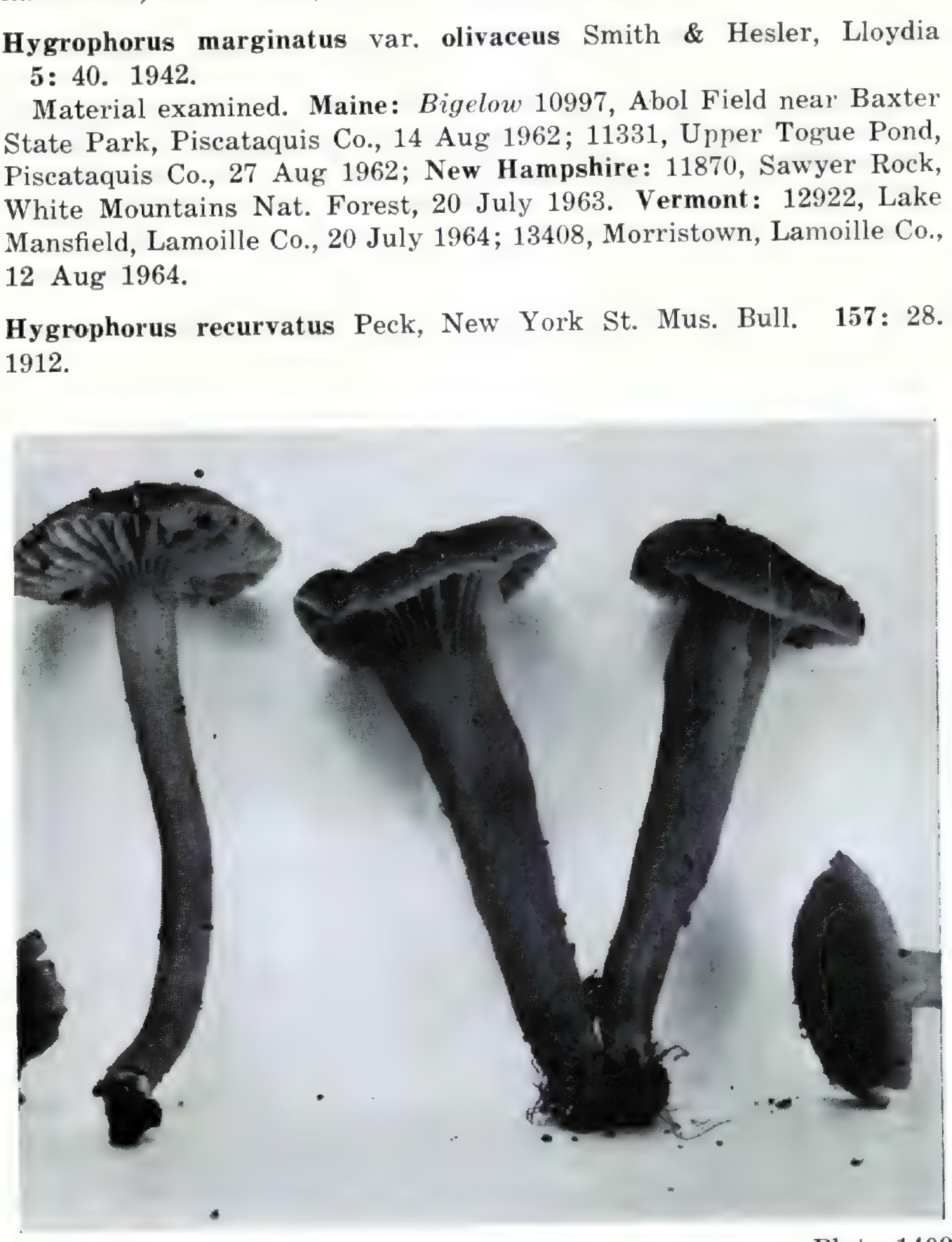


Plate 1409

Plate 1409. *Hygrophorus schulzeri* Bresadola. × 2.

Plate 1410. *Mycena citrinomarginata* Gillet. × 2.

Material examined. **Massachusetts:** *Bigelow* 14985, Conway, Franklin Co., 24 Oct 1966.

Gregarious or subcespitose, on lichen-covered very rotten conifer stump in old pasture.

Hygrophorus schulzeri Bresadola, Fungi Trident. 1: 57. 1884. Plate 1409.

Material examined. **Connecticut:** *Bigelow* 15493, Audubon Center, Sharon, Litchfield Co., 27 July 1968. **Massachusetts:** 15225, Mt. Toby, Sunderland, Franklin Co., 10 Aug 1967.

Gregarious or subcespitose, under hardwoods or mixed woods.

Hygrophorus tephroleucus (Fr.) Fr. var. **tephroleucus,** Epicrisis p. 328. 1838.

Material examined. **Vermont:** *Bigelow* 14366, Worcester, Washington Co., 5 Oct 1964.

Gregarious, on sphagnum patch in spruce woods.

Mycena citrinomarginata Gillet, Les Hyménomycètes, p. 266. 1874.

Plate 1410.

Pileus 4-20 mm broad, subcylindric at first becoming conic then conic-campanulate, subviscid but soon merely moist, opaque, sulcate striate, edge crenate or ragged in age, glabrous, fuscous umber fresh, hygrophanous and slowly fading to sordid yellow; context thin, not fragile, concolorous and fading with pileus, odor strong, earthy or raphanoid when flesh is crushed, taste similar.

Lamellae adnate to subdecurrent, close to subdistant, narrow to moderately broad, grayish, edges fimbriate and brown marginate.

Stipe 2-5 cm long, up to 2 mm thick at apex, equal or the base slightly enlarged, base tomentose, surface above with a thin fibrillose coating, glabrescent, central, hollow, often curved, sordid yellow.

Spores (7-)8-10(-12.5) × 4.5-6 μ, elliptic, smooth, amyloid. Basidia 23-35 × 6-8 μ, 4-spored. Cheilocystidia 22-55 μ long, fusoid ventricose, apex 1.5-3 μ broad, 6-8 μ broad at enlarged portion, branched and flexuous at times, hyaline. Pleurocystidia not found. Pileus cutis vinaceous in Melzer's, brown in KOH at first but fading to yellowish, pigment in cell contents, surface with thin gelatinous pellicle, cutis of flexuous and branched hyphae, 1-2 μ in diameter, with numerous digitate processes, some hyphae originating in hypoderm, cellular hypoderm conspicious, cells 22-50 μ broad, tramal hyphae cylindric to inflated, 2-16 μ in diameter. Hymenophoral trama subcellular, hyphae or cells 3.5-24 μ in diameter, dextrinoid in Melzer's. Clamp connections present.

Gregarious or cespitose, on lawn in the open.

Material examined. **Massachusetts:** *Bigelow* 14911, Baptist Hill, Conway, Franklin Co., 2 Oct 1966; 15613, same locality, 20 Oct 1968.

The collection cited appears to be the dark form of *M. citrinomarginata* discussed by Smith (1947). Besides pileus color, this form differs in other respects from the pale form as described by Smith. He gives the odor and taste as 'not distinctive", the pellicle as "non-gelatinous", and no mention is made of digitate processes as found on the cutis hyphae of no. 14911. Whether these differences are sufficient to separate the dark form with at least varietal status is uncertain in view of the extreme variability found in this species by Smith.

Plate 1411

Plate 1411. *Tricholomopsis sulphurea* (Pk.) Bigelow. × 1½.

Tricholomopsis sulphurea (Pk.) Bigelow, *comb. nov.* Plate 1411.

Clitocybe sulphurea Peck, New York State Mus. Rep. 41: 62. 1888.

Pileus 2.5-6(-9.4) cm broad, convex at first with an incurved margin, becoming broadly convex or plane with a decurved margin, subumbonate to somewhat umbilicate or shallowly depressed, margin even, surface glabrous, often lubricous when moist, at times slightly fibrillose at the margin under a lens, disc sometimes slightly velvety, subhygrophanous, a watery dull yellow moist (near "honey yellow"), paler yellow faded (near "colonial buff" or "deep colonial buff"), streaked when fading; context thin, pliant, pale yellow, odor and taste mild. Orange to reddish in KOH then brown.

Lamellae adnate or somewhat sinuate, close to subdistant, broad (up to 10 mm), abruptly tapered near pileus margin, not forked or intervenose, light yellow ("maize yellow" to "naples yellow"), darkening in age (near "chamois") but not changing color when bruised, edges crenate.

Stipe 2-4(-5) cm long, 5-9(-11) mm thick at apex, equal or the base swollen, usually curved, stuffed then hollow, surface innately fibrillose striate, concolorous with pileus or lamellae but fading more slowly, eccentric at times.

Spores (5.5-)6-8 × (4-)4.5-5.5(-6) μ, broadly elliptic, smooth, not amyloid, white in deposit. Basidia 23-37(-41.5) × (4-)6-7.5 μ, 4-spored, hymenium yellow to golden in KOH. Cheilocystidia abundant, clavate to bulbous, pedicellate, 25-58 μ long, (8-)11-23(-27) μ in diameter, hyaline or contents yellowish to orangish, walls slightly thickened, smooth, agglutinated in age. Pleurocystidia scattered or rare, cylindric to somewhat fusoid or subclavate, (25-)46-70 μ long, 4.5-8.5 μ in diameter, hyaline and shiny, smooth. Pileus section reddish at first in KOH but soon fading, cutis dingy orangish or golden-yellow, pigment as fine encrustrations or in slightly thickened walls, cutis hyphae mostly cylindric, 4-8.5 μ in diameter, trama paler than cutis, hyphae cylindric to inflated, 4-15.5 μ in diameter, walls thin or slightly thickened. Hymenophoral trama of parallel or subparallel hyphae, hyaline or pale yellowish, hyphae cylindric or somewhat inflated, 4-13 μ in diameter, walls thin or slightly thickened. Clamp connections present. Colored refractive hyphae present.

Scattered or gregarious, on conifer logs. September and October.

Material examined: **Massachusetts:** *Bigelow* 9395, Mt. Toby, Sunderland, Franklin Co., 2 Oct 1960; 11569, Shutesbury, Franklin Co., 9 Oct 1962; 14658, Conway, Franklin Co., 19 Oct 1965; 15309, Conway, Franklin Co., 10 Oct 1967. **New York:** *C. H. Peck*, Wittenburg Mountain, Sept (type) (NYS). **Vermont:** *Bigelow* 14270, Ranch Brook trail, near Stowe, Lamoille Co., 28 Sept 1964.

The discovery that this species of Peck's is a *Tricholomopsis* necessitated a comparison with three other North

American species of this genus. The types of *Agaricus (Pleurotus) sulphureoides* Peck, *Agaricus (Tricholoma) flavescens* Peck, and *Tricholomopsis bella* Smith, were re-examined with special attention to the details of pigmentation in the pileus cutis. On the basis of microscopic characters, the species can be separated into two groups. A *sulphureoides* and *A. flavescens* had no encrusted hyphae when studied with a phase microscope and 100X oil immersion objective, but encrusted hyphae were found on the cuticular hyphae of the types *Clitocybe sulphurea* Peck and *T. bella*. In the first two, the coloration appears to be dilute in the cell contents and in slightly thickened smooth walls. In addition to the differences in pigment, *C. sulphurea* and *T. bella* had larger cheilocysts (viz. 35-60 × 15-23 μ, and 23-75 × 10-25 μ, respectively) than *A. sulphureoides* and *A. flavescens* (33-50 × 7.5-13 μ and 31-44 × 9-17.5 μ respectively).

Further distinction between the species is by means of macroscopic features. With the types of *A. sulphureoides* and *A. flavescens* (NYS) are watercolor sketches and these present different appearing agarics. *A sulphureoides* has numerous small dark brown scales over a dull sulphur yellow ground color and a small brownish umbo. In comparison with the sketch of *A. flavescens, A. sulphureoides* is smaller, has thinner flesh, and is a generally more intensely colored species. *A. flavescens* is light yellow (almost citrine yellow), glabrous, and with a rather robust *Tricholomoid* stature. In the original descriptions Peck stated that *A. sulphureoides* can be smooth, and that *A. flavescens* can crack into minute scales on the disc, but these conditions are not evident in the sketches. The microscopic characters of the two types are nearly identical.

T. bella is separated from *T. sulphurea* also by field characters. The pileus surface of *T. bella* is coarsely fibrillose with squamules on the umbo and margin. The color is darker — dull ochraceous beneath darker ochraceous fibrils in contrast to the yellow shades of *T. sulphurea*. The lamellae of *T. bella* stain dull rusty brown when bruished,

a state not observed in *T. sulphurea.* Pleurocystidia are rare and difficult to find in sections of *T. sulphurea,* but are abundant in *T. bella.* The latter has been found in New England and is described below to add information to the type description.

By the scaly cap, *T. ornata* (Fr.) Sing. appears to be closest to *T. sulphureoides,* but this European species has spores which are elliptic-cylindric, 5.5-8 × 3.3-4 μ, according to Favre (1952). The cheilocysts of *T. ornata* often have appendages, which I did not find in the type of *A. sulphureoides.* There is no information given by Favre about the details of pigmentation nor about pleurocystidia.

In Smith's (1960) treatment of *Tricholomopsis* a fibrillose veil was emphasized in distinguishing *T. sulphureoides* from *T. flavescens* (as *T. thompsoniana*) and *T. bella.* The relation of *C. sulphurea* was not known at this time and thus not compared. Of the four types, none are known definitely to have a veil by the author's descriptions. The sketches with the types of *A. sulphureoides* and *A. flavescens* (NYS) do not show veils unfortunately, and the specimens of all four type collections are too expanded to show any distinct veils even if present when young. All were examined under the dissecting microscope, but the very few fibrils visible on the pilei margins or stipe apices at times were inconclusive evidence of a veil. However, veils do exist in this group as Smith reported for *T. sulphureoides,* and as known now in *T. bella,* Bigelow no. 15325. The presence or absence of a veil is a difficult characteristic to use in diagnosis of a species in this group though, as rarely does one collect carpophores small enough to distinctly show, or rule out, this structure.

Of possible use in further assisting the separation of the four species discussed above is the reaction of fresh carpophores to 3% KOH. All of the species have not been tested yet, but two collections of *T. sulphurea* showed a distinct orange to red color when drops of KOH were placed on any part. Slowly, the color changed to dull brown.

Plate 1412

Plate 1412. *Tricholomopsis bella* Smith. × 1½.

Tricholomopsis bella Smith, Brittonia **12:** 64. 1960. Plate 1412.

Pileus (0.8-)2.5-6.5 cm broad, convex with a strongly incurved margin at first, expanding to broadly convex, with a low broad umbo at times, margin edge tomentose in buttons then appressed squamulose, appressed fibrillose-scaly or coarsely radiate fibrillose to the rather velvety disc, subhygrophanous at times, ochraceous (nearest "antimony yellow"), disc slightly darker in expanded pilei, paler and more yellowish in age and loss of moisture; context thin except on disc, firm, ochraceous to yellow, no odor and taste.

Lamellae adnexed usually but adnate or short decurrent in large specimens, close, moderately broad, concolorous with the pileus or more yellowish, not fading, edges crenate, becoming brown in age and bruising.

Stipe 2.5-4.5 cm long, 5-10 mm thick at apex, equal or base enlarged, hollow, surface fibrillose, heavily fibrillose at apex in buttons and fibrils attached to pileus edge, soon ruptured, concolorous with moist pileus but base becoming watery brownish when bruised.

Spores 5.5-7 × (3.5-)4.5-5.5 μ, broadly elliptic or elliptic, smooth, not amyloid, white to faintly cream in deposit. Basidia 36-40 × 5.5-7 μ, 4-spored. Cheilocystidia clavate to clavate-bulbous, pedicellate, at times basidioid or irregular-cylindric, hyaline or golden yellow, 23-65 μ long, (4.5-)10-22.5(-26) μ broad, usually abundant. Pleurocystidia basidioid to cylindric in shape but refractive, pale yellowish, embedded, 31-61 μ long, 5-6 μ broad, scattered at times. Pileus cutis brownish golden in KOH, pigment finely encrusted or in slightly thickened walls, hypae mostly cylindric, 5.5-11.5 μ in diameter, trama pale yellow, hyphae cylindric or somewhat inflated, 4.5-15.5 μ in diameter. Hymenophoral trama subparallel, yellowish in KOH (paler than hymenium), hyphae mostly slightly inflated, (6-)8.5-19 μ in diameter, walls often slightly thickened. Clamp connections present. Yellow refractive hyphae present.

Scattered on conifer log. September.

Material examined. **Massachusetts:** *Bigelow* 15325, Conway, Franklin Co., 28 Sept 1967. **Michigan:** *Smith* 42508 (type), Wilderness Point, Emmet Co., 7 Sept 1953. (MICH) **New Hampshire:** *Bigelow* 12429, South Conway, Carroll Co., 4 Sept 1963.

ASCOMYCETES

Berlesiella nigerrima (Blox.) Sacc. Rev. Mycol. **10:** 7. 1888. Figs. 1-5.

Sphaeria nigerrima Bloxam ex Currey, Linn. Soc. London Trans. **22:** 272. 1858.

Pleospora nigerrima (Blox.) Sacc. Syll. Fung. **2:** 276. 1883.

Dothidea episphaeria Peck, New York St. Mus. Rept. **30:** 64. 1878.

Phyllachora episphaeria (Pk.) Sacc. Syll. Fung. **2:** 608. 1883.

Bertia parasitica H. Fabre, Ann. Sci. Nat. Bot. 6 sér. **9:** 95. 1878.
Homostegia parasitica (Fabre) Rehm, Hedwigia **26:** 96. 1887.
Berlesiella parasitica (Fabre) v. Höhnel, Sitzungsber. Kais. Akad. Wiss. Wien, Math.-nat. Kl. Abt. 1, **124:** 60. 1915.
Pachythyrium parasitica (Fabre) Arnaud, Soc. Myc. Fr. Bull. **69:** 302. 1953. Nom. non spec.
Trichothyrina parasitica (Fabre) v. Arx in Müller & v. Arx, Beitr. Kryptogamenfl. Schweiz 11(2): 559. 1962. Nom. non spec.
Valsa pulviniceps Peck, New York St. Mus. Rept. **32:** 50. 1879.
Cryptospora pulviniceps (Pk.) Sacc. Syll. Fung. **9:** 940. 1891.
Anthostoma pulviniceps Peck in Ellis & Ev. North Amer. Pyreno. p. 578. 1892.
Cucurbitaria setosa Ell. & Ev. Phila. Acad. Nat. Sci. Proc. **42:** 241. 1890, non *C. setosa* Winter.
Berlesiella setosa (Ell. & Ev.) Sacc. Syll. Fung. **9:** 915. 1891.
Gibberidea setosa (Ell. & Ev.) Kuntze, Rev. Gen. Pl. **3**(3): 481. 1898.
Cucurbitaria echinata Ell. & Ev. North Amer. Pyreno. p. 240. 1892, nom. nov. for *C. setosa* Ell. & Ev.
Berlesiella echinata (Ell. & Ev.) Berl. Icon. Pyren. **2:** 112. 1897.
Pleosphaeria echinata (Ell. & Ev.) Miller, Mycologia **33:** 78. 1941.

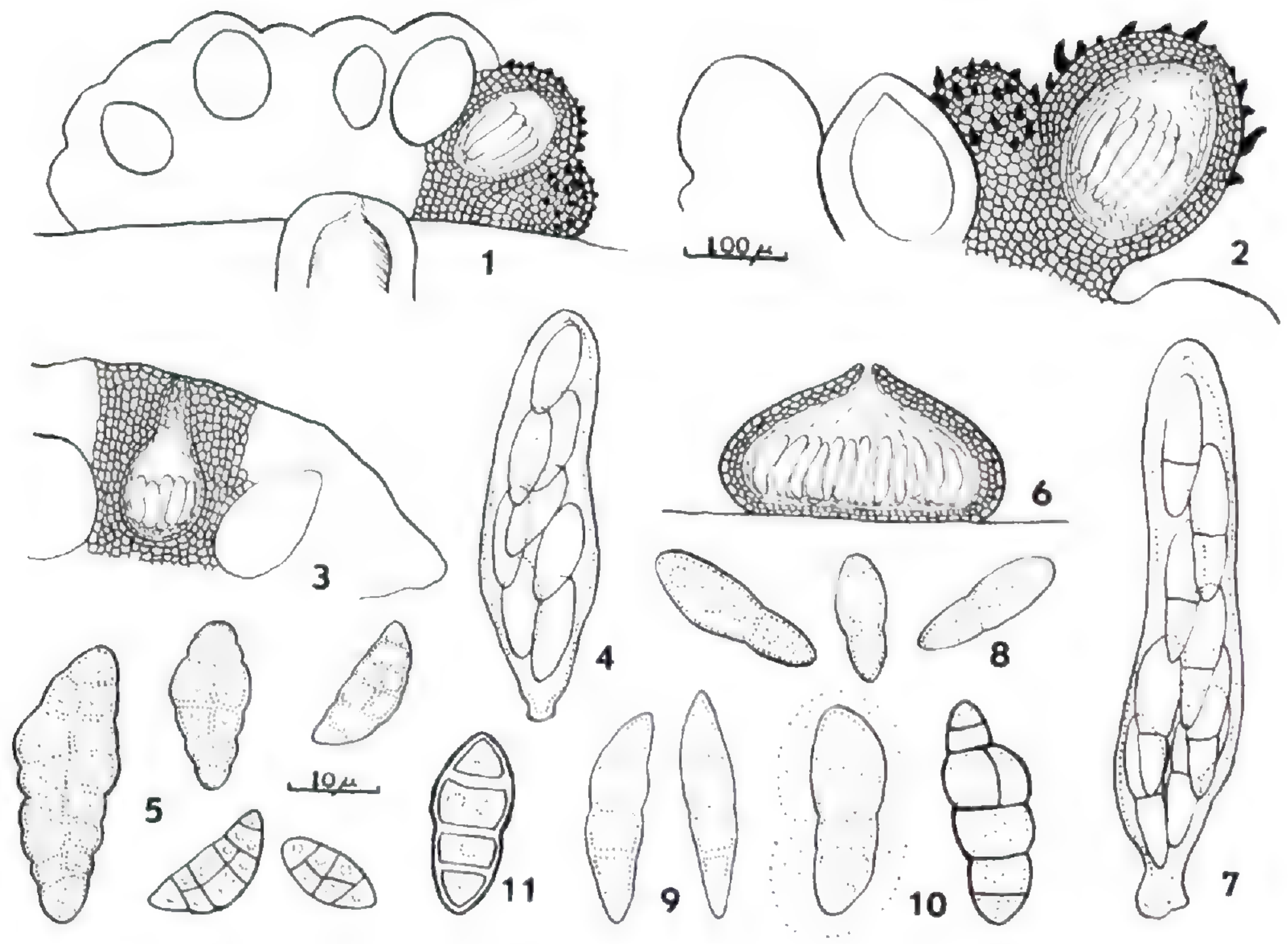
Stromata velvety black, superficial on ostioles or stromata of members of Diatrypaceae, pulvinate, 1-2 mm diameter or larger by confluence, 120-460 μ high, surface regular or raised into rounded protuberances by erumpent upper portions of locules, roughened by hyphal tips, short cells, or setae up to 48 μ long, dark reddish brown to black; locules entirely immersed in stroma or partially erumpent, globose or laterally compressed and conic, 50-120 μ in diameter, 85-200 μ high, locule wall reddish brown, composed of several layers of polygonal cells and narrow hyaline inner layers, stromatic tissues of polygonal brown or reddish brown cells, blackened toward surface, often in upright rows in interior, opening by lysigenous canal and pore, stuffed with ± gelatinizing hyphae and appearing periphysate. Asci 36-67 × (7.5-)9.5-16(-24) μ, oblong to saccate, bitunicate, apex rounded and thickened, narrowed to foot-like base, in gelatinizing remnants of locule tissue. Ascospores 12-20(-24) × 4-6(-7.5) μ, light dull brown or olivaceous brown, obovate-fusoid, straight to inequilateral, (3-4-)5-6-(7-) septate, one vertical septum in one or all of middle cells but not extending through end cells, slightly constricted at the septa and cells protruding out to form a rather irregular outline, one or two globules in each cell, wall smooth, overlapping biseriate or crowded in the ascus.

Superficial, hypersaprophytic on old stromata of members of Diatrypaceae.

Material examined. **Massachusetts:** *Barr* 5248, Mohawk Trail State Forest, Franklin Co., 4 Oct 1968; **New York:** *Peck*, Maryland, Otsego Co., Sept (type of *Dothidea episphaeria*, NYS); Richmondville, Schoharie Co., Sept 1878 (type and isotype of *Valsa pulviniceps* and *Anthostoma pulviniceps*, NYS). **Ontario:** *Dearness*, London, July 1894 (as *Cucurbitaria echinata*, Ell. & Ev. N.A.F. 3109). **France:** *Rehm*, Ascom. exs. 2175 as *Bertia parasitica* (MICH); *Flageolet*, Rigny-sur Arroux, Saone-et-Loise, 1918 as *Berlesiella nigerrima* (NYS).

The collections listed above vary in appearance of the stroma. Completely immersed locules with only scattered hyphal tips roughening the surface occur in *Dothidea episphaeria* (fig. 3). Slightly protruding apices of locules, covered by numerous short black cellular contorted setae are found in *Bertia parasitica* (fig. 1). Mostly erumpent locules whose stromatic surface bears more elongate pointed setae in *Cucurbitaria echinata* and *Valsa pulviniceps* (fig. 2) complete the series. The locules, asci, and ascospores are all similar within the size range described. Only one rather variable species seems to be involved. Chenantais (1921) has discussed the synonymy of *nigerrima — setosa — parasitica*. He was unable to study Peck's *Dothidea episphaeria* to determine its disposition. Peck misinterpreted the fungus called *Valsa pulviniceps*, for his description included that of perithecia of the *Eutypa* as well as the locules with asci and ascopores of the *Berlesiella*. Fabre's *Bertia parasitica* has been involved in the synonymy of *Trichothyrium epimyces* (Sacc., Bomm. & Rouss.) Theissen. This latter species is also hypersaprophytic on other pyrenomycetes, but has small flattened ascostromata with radiating wall structure and hyaline one-septate ascospores. Fitzpatrick (1923), Arnaud (1953), and Müller and von Arx (1962) included *Bertia parasitica* with *Microthyrium epimyces* and *Nitschkea flageoletina* Sacc. However, Fabre's original description and figures of *Bertia parasitica* indicate that his fungus was indeed *Berlesiella* rather than *Trichothyrium*.

The genus *Berlesiella* is presently the only stromatic member of the small family Herpotrichiellaceae Munk.



Figures 1-11

Figs. 1-5. *Berlesiella nigerrima:* 1-3, sections through stromata of varying types, 4, ascus, 5, ascospores. Figs. 6-8. *Seynesiella exigua:* 6, ascostroma in section, 7, ascus, 8, ascospores. Fig. 9. *Leptosphaeria macrospora*, ascospores. Fig. 10. *Pleospora vitalbae*, ascospores. Fig. 11. *Thyridaria rubro-notata*, ascospore.

Earlier (in Bigelow and Barr, 1963) I followed Müller and von Arx (1962) in placing members of this family among the Pleosporaceae, but now consider that the Herpotrichiellaceae must be upheld. Despite the few species presently recognized and the lack of developmental studies, the mature locule represents more the Dothidea than the Pleospora type of development. The family Herpotrichiellaceae is tentatively considered most closely allied to the Capnodiaceae in the Dothideales.

Seynesiella exigua Barr, *sp. nov.* Figs. 6-8.

Ascostromata 200-265 μ diametro, 100 μ alto, poro 10.5-12 μ pertuso, peridio lateralis brunneis, radiatis, basalis tenuissima. Asci 36-60 × 7.5-9 μ, bitunicatae, oblongis vel saccatis. Ascosporae 10.5-15 × 3-4.5 μ, pallidae viridae, ellipticae, infra medium septatae.

Specimen typicum in foliis emortuis *Juniperi communi* L., prope

"Lac Diable, Mont Albert, Gaspé Provincial Park, Quebec, 19 Aug 1957", a **M. E. Barr** n. **2202** lectus; in herb. Univ. Mass. depositum.

Ascostromata 200-265 μ in diameter, about 100 μ high, pore 10.5-12 μ wide, basal wall thin and light brown, side walls blackish brown, of radiating rows of cells. Asci 36-60 $\times$ 7.5-9 μ, bitunicate, apex thickened, oblong to somewhat saccate, sessile, pseudoparaphysate. Ascospores 10.5-15 $\times$ 3-4.5 μ, greenish hyaline, elliptic, straight to inequilateral, septate below middle, constricted at septum, wall smooth, contents with two or three globules in each cell, crowded in the ascus.

On dead leaves of *Juniperus communis* L.

Material examined. **Maine:** *Barr* 4789, Yellowhead Point, near New Harbor, Lincoln Co., 30 July 1965. **New Hampshire:** 3880, South Conway, Carroll Co., 11 July 1963. **Quebec:** 2194, 2202 (type), Lac Diable, Mont Albert, Gaspé Prov. Park, 19 Aug 1957. **Vermont:** 4278, Stowe Pinnacle trail, near Stowe, Lamoille Co., 11 July 1964.

This fungus is similar in appearance to *Seynesiella juniperi*, the type species of the genus. It differs from the previously described species by its much smaller ascospores. *Stigmatea sylvatica* Sacc. was described from leaves of *Juniperus*, but has ascostromata 110-120 μ in diameter and hyaline ascospores 10 $\times$ 3 μ. *Seynesiella*, with applanate ascostromata, radiating wall structure, and thin basal wall, seems best placed in the Microthyriaceae of the Hemisphaeriales.

Three species belonging to the Pleosporaceae are reported from North America for the first time. These are:

Leptosphaeria macrospora (Fckl.) Thümen, Myc. univ. n. 1359. 1879. Fig. 9.

Material examined. **Maine:** *Barr* 3339, on *Rumex obtusifolius*, Katahdin Lake trail, Baxter State Park, Piscataquis Co., 7 July 1962. **Vermont:** 4482, on *Eupatorium fistulosum*, Munroe State Park, North Duxbury, Washington Co., 6 Aug 1964.

The ascospores of these two collections are in the low end of the size range given by Holm (1957) — (20-)28-33 $\times$ 4-5.5 μ for the North American collections, 29-40 $\times$ 4.5-6 μ for European collections. They approach *L. senecionis* (Fckl.) Winter in size (24-30 $\times$ 6.5-7.5 μ according to Holm), but differ in shape. Those of *L. macrospora* taper to a point especially at the basal end, while in *L. senecionis* the ends are obtuse. *L. macrospora* is an entirely different fungus from *Pyrenophora macrospora* (Schroet.) Wehm., although both were originally described as *Pleospora*. Schroeter's name is the later

and a new name must be provided for the species now called *Pyrenophora macrospora*.

Pleospora vitalbae (de Not.) Berl. Nuov. Giorn. Bot. Ital. **20:** 70. 1888. Fig. 10.

Material examined. **Maine:** *Barr* 3741, on *Clematis virginiana*, Katahdin Lake trail, Baxter State Park, Piscataquis Co., 1 Sept 1962.

The ascospores of *P. vitalbae* have a single vertical septum in one or two of the middle cells, and the species was described in *Leptosphaeria*. This fungus is known from *Clematis* in Europe and also from *Ilex* from Argentina, but has not been reported from North America to my knowledge.

Thyridaria rubro-notata (Berk. & Br.) Sacc. Syll. Fung. **2:** 141. 1883. Fig. 11.

Material examined. **Vermont:** *Barr* 4306, on *Acer* bark, Stowe Hollow, Lamoille Co., 14 July 1964.

The grouped ascostromata of *T. rubro-notata* have a vinaceous tinge to the hyphae of the papillate apices. Wehmeyer (1941) described the species from European specimens.

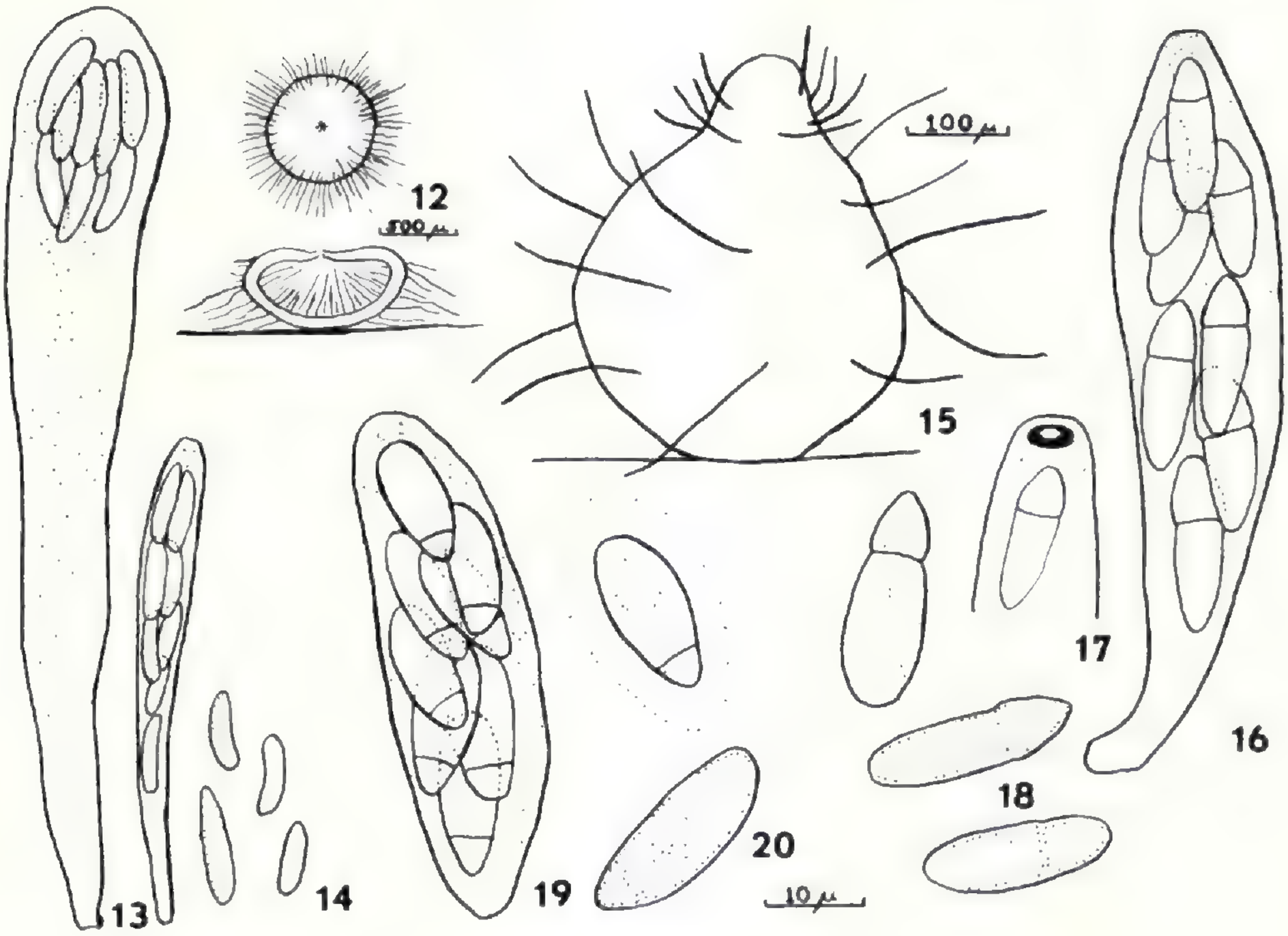
Enchnoa subcorticalis (Peck) Barr *comb. nov.* Figs. 12-14.

Sphaeria subcorticalis Peck, New York St. Mus. Rept. **28:** 77. 1876.

Trichosphaeria subcorticalis (Peck) Sacc. Syll. Fung. **1:** 454. 1882.

Perithecia scattered to grouped beneath bark and often adhering to bark when the latter is removed, 540-1000 μ in diameter, depressed globose and collapsing cupulate, surrounded by fringing hyphal tomentum, hyphae dark brown, thick-walled, distantly septate, 4.5-6.5 μ wide; perithecial wall fragile but thick, externally 50-66 μ wide, composed of layers of polygonal brown cells, internally 80-115 μ wide, composed of layers of light brown to hyaline compressed cells; apical pore minute. Asci numerous, unitunicate, arising from inner wall layers among delicate, hyaline paraphyses, of two sizes: 1) clavate, long-stipitate (55-100 $\times$ 5-6 μ), p.sp. 44-55 $\times$ 10-16.5 μ, with rounded or conical apex; 2) elliptical, short-stipitate, 27.5-30 $\times$ 5.5-6.5 μ, neither ascus type bearing apical apparatus or staining differentially, irregular opening visible at apex of empty asci, 8-spored. Ascospores similar in both types of asci, 7.5-11(-14) $\times$ 1.5-2.5(-3) μ, greenish hyaline, yellowish, to light olive- or gray-brown, cylindric to allantoid, ends rounded, rarely narrowed, 1-celled or at times with a pseudoseptum, contents minutely guttulate or as single globule, wall thin and smooth, clustered near apex of large asci, overlapping biseriate in small asci.

On old branches of *Carpinus caroliniana*, among remnants of stromatic pyrenomycetes.



Figures 12-20

Figs. 12-14. *Enchnoa subcorticalis:* 12, perithecia from above and in section, 13, two asci illustrating size differences, 14, ascospores. Figs. 15-18. *Pseudomassaria inversa:* 15, perithecium, 16, ascus, 17, ascus apex with amyloid annulus, 18, ascospores. Figs. 19-20. *Pseudomassaria thistletonia:* 19, ascus, 20, ascospores.

Material examined. **Massachusetts:** *Barr* 5131, Mt. Toby, Sunderland, Franklin Co., 14 May 1968. **New York:** *Peck,* North Greenbush, Rensselaer Co., June 1874 (type, NYS).

For making disposition of Peck's fungus, the characteristics of large depressed perithecia surrounded by hyphal tomentum and allantoid ascospores agree with those of other species of *Enchnoa.* The formation of two sizes of asci is a distinctive feature of this species, and indeed is most uncommon in the pyrenomycetes.

The genus *Enchnoa* is not well known and has been relegated to several families in the past. Von Höhnel's (1909, 1918) suggestion of close relationship between *Enchnoa* and *Calosphaeria* has much merit. These two genera, with a few others, comprise the family Calosphaeriaceae in which the perithecia are scattered to grouped,

with a thick but fragile wall, containing asci in broad paraphyses, with ascospores typically allantoid, rarely elliptical or short cylindrical. In the Xylariales, the Calosphaeriaceae seem most closely related to the Sphaeriaceae.

Pseudomassaria inversa Barr, *sp. nov.* Figs. 15-18.

Perithecia 270 μ diametro, 350 μ alta, conica, erumpente vel superficialia, peridium usque ad 23 μ crassum, brunneum vel hyalinum introrsum, pilis septatis, 65-350 μ × 4-5.5 μ vestitis. Asci 65-88 × 13-17.5 μ, elliptici vel oblongi, unitunicati, ad apicem cum poro amyloideo, paraphysati. Ascosporae 17.5-21(-25.5) × 5-6.5 μ, hyalinae vel viridae, ellipticae vel ovatae, apicis versus uniseptatis, cellula apicalis 6-7.5 μ longa.

Specimen typicum in foliis *Rhododendri lapponici,* prope "Alpine Gardens, Mount Washington, New Hampshire, 19 Aug 1963", a **M. E. Barr** n. **4104a** lectus; in Herb. Univ. Mass. depositum.

Perithecia erumpent to superficial, scattered on lower leaf surface, 270 μ in diameter, 350 μ high, conic with papillate apex, wall of large blackish brown cells, up to 23 μ wide, the outermost layers polygonal and brown, inner layers compressed and hyaline, scattered setae over much of wall and grouped below papillate apex, setae septate, 65-350 μ long, 4-5.5 μ wide, not tapered, tips rounded and pallid, dark brown below. Asci 65-88 × 13-17.5 μ, elliptic or oblong, unitunicate, apex rounded-truncate, base short stipitate, apical annulus refractive in water, amyloid in Melzer's, in deliquescent paraphyses. Ascospores 17.5-21(-25.5) × 5-6.5 μ, greenish hyaline, elliptic to ovate, straight, ends rounded, 1-septate toward upper end, not constricted, upper cell 6-7.5 μ long, contents guttulate, wall smooth, overlapping biseriate in the ascus.

On dead fallen leaves of *Rhododendron lapponicum.*

Material examined. **New Hampshire:** *Barr* 3859c, Alpine Gardens, Mt. Washington, White Mountains Nat. Forest, 9 July 1963; 4104a (type), 4109b, same locality, 19 Aug 1963.

This species deviates from all others in *Pseudomassaria* by the septation of ascospores in the upper rather than lower third. In all other respects, *P. inversa* is typical of the genus and is closest to the species such as *P. erumpens* and *P. oxydendri. P. inversa* cannot be confused with the other species occurring on *Rhododendron* leaves, *P. thistletonia* or *Chaetapiospora rhododendri,* since they are smaller, immersed in the host tissues or only partially erumpent.

This and the following species are members of the family Amphisphaeriaceae in the Xylariales.

Pseudomassaria thistletonia (Cke.) von Arx, Ber. Schweiz. Bot. Gesell. **62:** 355. 1952. Figs. 19-20.

Physalospora thistletonia Cooke, Grevillea **18:** 74. 1890.

Pseudapiospora thistletonia (Cke.) Petrak & Sydow, Ann. Mycol. **27:** 98. 1929.

Perithecia immersed, few in gray or pallid areas in leaf spots, 140-170 μ in diameter, depressed globose, wall thin, 15 μ wide, layers of light brown, compressed cells, blackened around apical pore, pore periphysate, apex glabrous or bearing one to two setae. Asci 42-75 $\times$ 11-15 μ, elliptical, unitunicate, apex and base rounded, apical annulus amyloid, no pulvillus visible, in thin-walled deliquescent paraphyses. Ascospores 15.5-20 $\times$ 5.5-7.5 μ, greenish or yellowish hyaline, elliptic to obovate, tapered to rounded ends or base pointed at times, straight to inequilateral, 1-septate near base, not constricted, basal cell 2-3.5(-4) μ long, contents guttulate, wall thin and smooth, in fresh material surrounded by gelatinous coating 4 μ wide, obliquely biseriate in the ascus.

Epiphyllous in leaf spots formed by *Guignardia rhodorae* (Cke.) B. H. Davis, on *Rhododendron maximum.*

Material examined. **Maryland:** *Cory,* New Germany, 23 Aug 1946 (BPI, as *Venturia rhododendri*). **New Hampshire:** *Barr* 5152, Rhododendron State Park, Fitzwilliam, Cheshire Co., 25 June 1968.

P. thistletonia was described from England and later discussions of the species apparently refer only to the type collection. The specimens cited agree with the descriptions. *Chaetapiospora rhododendri* (Tengwall) von Arx differs in conic, partially erumpent perithecia bearing numerous elongate setae, and narrow ascospores 12-18 $\times$ 3-4.5 μ, *P. thistletonia* is closely related to *P. leucothoës* (Cke.) Petrak & Sydow, and may be distinguished from the latter species by the few setae and by the host plant.

Records of three members of the Pezizales are included. These species appear to be collected infrequently.

Plicaria trachycarpa (Currey) Boud. Soc. Myc. Fr. Bull. 1: 102. 1885.

Material examined. **Maine:** *Barr* 3732, Bear Brook, T4 R9, Piscataquis Co., 31 Aug 1962.

Pseudombrophila deerrata (Karst.) Seaver, North American Cup-Fungi (Operculates), p. 141. 1928.

Material examined. **Massachusetts:** *Barr* 5141, Conway, Franklin Co., 15 June 1968.

Gregarious to cespitose on overwintered cabbage stalks.

This discomycete was reported from North Dakota and New York by Seaver. The collection cited contained several dozen small pinkish to brown apothecia. The microscopic characters agree with Seaver's (1942) and Dennis's (1968) descriptions, although I found the paraphyses to be somewhat enlarged at the apex and encrusted with brown pigment.

Trichophaea bullata Kanouse, Mycologia **50:** 131. 1958.

Material examined. **Connecticut:** *Barr* 5200, Sharon Audubon Center, Litchfield Co., 27 July 1968. **Massachusetts:** 5058, Conway State Forest, Franklin Co., 29 Aug. 1967.

Apparently *T. bullata* is not uncommon in eastern North America, judging from these recent collections. Like several other species of *Trichophaea*, it has the aspect of a miniature *Humaria hemispherica* (Fr.) Fckl., with whitish hymenium and brown exterior and marginal hairs. The enlarged bases of the hairs provide a ready means of identification of the species.

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A REVIEW OF THE VARIETIES OF POLYMNIA UVEDALIA[1]

JAMES R. WELLS

More than fifty years ago three varieties of *Polymnia uvedalia* (L.) L. were described (Blake 1917). The varieties are: *uvedalia* — pedicels and inflorescence branches densely stipitate-glandular, sessile glands present; hispid-pilose hairs none or few; *floridana* — pedicels and inflorescence branches with sessile or nearly sessile glands; hispid-pilose hairs infrequent; *densipilis* — glands inconspicuous; hispid-pilose hairs frequent.

Although authors of recent manuals and floras usually have failed to treat these varieties, they were listed in a recent review of the genus (Wells 1965). Some additional comment upon their significance is perhaps justified as part of an overall effort to achieve a better understanding of this Western Hemisphere genus.

The distribution of *Polymnia uvedalia* by varieties (Fig. 1 plus Bermuda) is based upon examination of types as well as other herbarium material from BLH, F, GH, ILLS, IND, LSU, MEXU, MICH, MO, MSU, ND, NY, NCU, OS, OU, PH, SIU, SMU, TAES, TENN, TEX, US, and WIS. See Lanjouw and Stafleu (1964) for key to these abbreviations. Varieties are undetermined at sites indicated by "+", and the e. central Ill. record comes from R. P. Wunderlin (pers. comm.). In commenting upon varietal distributions, Blake (1917) noted that in the northern and eastern portion of the species range var. *uvedalia* predominates while in the west var. *densipilis* is most common. In the southern and southeastern part of the U. S. var. *floridana* is most frequently encountered. When the three varieties are mapped separately (Fig. 1) Blake's statement is substantiated but it should be noted that there is considerable overlap in ranges. Thus, varietal

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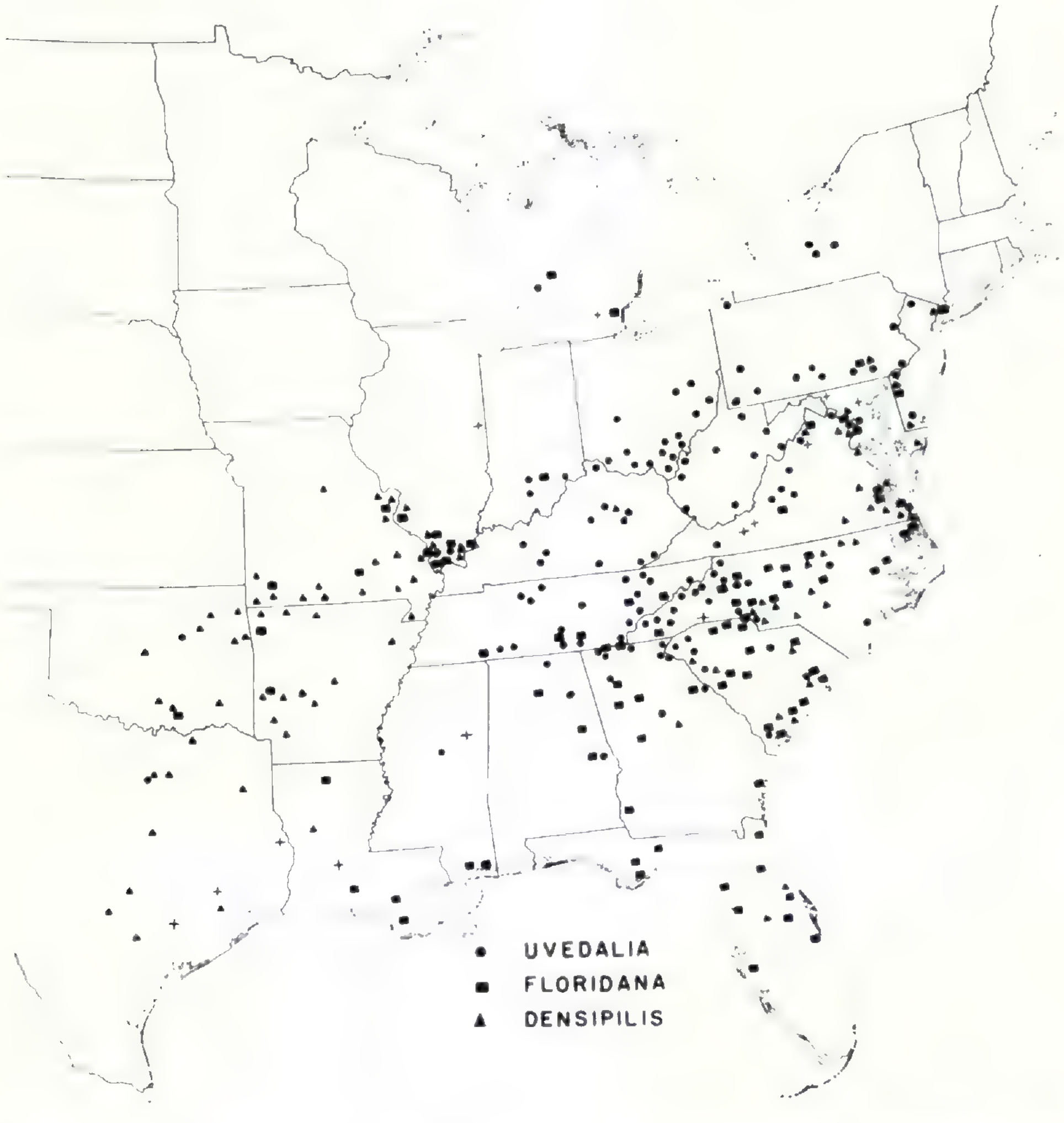


Fig. 1. Distribution of *P. uvedalia* (plus Bermuda). Varieties undetermined at sites marked "+".

distribution patterns represent only tendencies. In the field I have observed one variety growing within a few feet of another variety. The apparent absence of *P. uvedalia* from the northern portions of Ill., Ind., and Ohio is likely a result of prairie peninsular extension into those regions (Dansereau, pers. comm.). Otherwise, it seems to conform to most of the Gray's Manual range of coverage.

Although Bermuda is the only location of *Polymnia uvedalia* known to me outside the U. S., facts do not now support Blake's data (1917) on the occurrence of only var. *densipilis* on that island. Examination of Bermuda material

included specimens of all three varieties and in 1966 I collected living material of var. *floridana* there.

Results of attempts at hybridization among the varieties are listed below (Table 1). These results are in agreement

Table 1. SUMMARY OF HYBRIDIZATION ATTEMPTS

Pollen Parent	Ovule Parent	Crosses Attempted	Fruits Formed	
P. uvedalia var.			No.	Percent
floridana	*densipilis*	68	61*	90
densipilis	*floridana*	59	37	63
uvedalia	*floridana*	53	10*	19
floridana	*uvedalia*	50	38	76
densipilis	*uvedalia*	57	42	74
uvedalia	*densipilis*	95	54	57
floridana[B]	*uvedalia*	58	29	50
uvedalia	*floridana*[B]	54	23	43
floridana[B]	*floridana*	42	15*	36
floridana	*floridana*[B]	51	29	57
floridana[B]	*densipilis*	65	40	62
densipilis	*floridana*[B]	54	27	50
	TOTAL	706	405	57

* X^2 test results indicate significance at the 5% level in this reciprocal cross.

[B] Indicates Bermuda origin of var *floridana* plant.

with earlier reports (Wells 1966). The percentages of fruits formed are probably somewhat reduced due to accidental breakages of vascular connections between pistillate flowers and receptacle during emasculation. (Emasculation was carried out prior to anthesis in every cross.) The higher percentages of fruits formed in this study than formerly (Wells 1966) may reflect my increased facility in handling the material. With the exception of var. *floridana* from Bermuda the same cultures were used. Without emasculation, higher percentages of fruits are formed but self-fertilization and pseudogamy cannot be completely ruled out (Wells 1966).

In all of the 706 crosses only 4 plants were involved. Data involving var. *floridana* from Bermuda correspond to data obtained for the other two varieties from the U. S. Judging from comparative crossabilities between all varieties with var. *floridana* from Bermuda there is no apparent evidence for a distinct genetic race on this island. An unexpected reduction in fertility is indicated when var. *floridana* of U. S. origin is employed as the ovule parent. Significant differences involving this individual may arise due to chance occurrence of a genotypically unique *floridana* plant from the United States. Such events may occasionally be observed when minimal numbers of plants are involved in an experimental treatment.

Parent plants as well as their progeny had gametic counts of $n=16$ and meiotic pairing appeared normal. Only one cytological anomaly was detected and this tetraploid resulted from the cross of vars. *floridana* and *uvedalia*. Pollen stainability using analine blue in lactophenol was at least 90% in all cases.

The fruits of *Polymnia uvedalia* have thick, woody coats. Removal of at least 50% of the fruit coat prior to their placement on moist filter paper resulted in almost 100% germination. The seedlings grew rapidly under greenhouse conditions and the F_1 plants began to flower in about 70 days. Fruits matured approximately 21 days later.

Vestiture differences between vars. *densipilis* and *floridana* represent, to a great extent, a matter of degree rather than kind; therefore, phenotypic data from F_1, F_2, or backcrosses would represent at best a mere guess. Thus, Tables 2, 3, and 4 lack data showing crosses between these two varieties. It is clear from Table 1 that vars. *densipilis* and *floridana* can be crossed reciprocally. Seeds from these reciprocal crosses are viable and a total of 23 plants flowered. Peduncle vestiture appeared to be "intermediate" although this represents only a crude estimate.

Backcross data involving var. *floridana* as the ovule par-

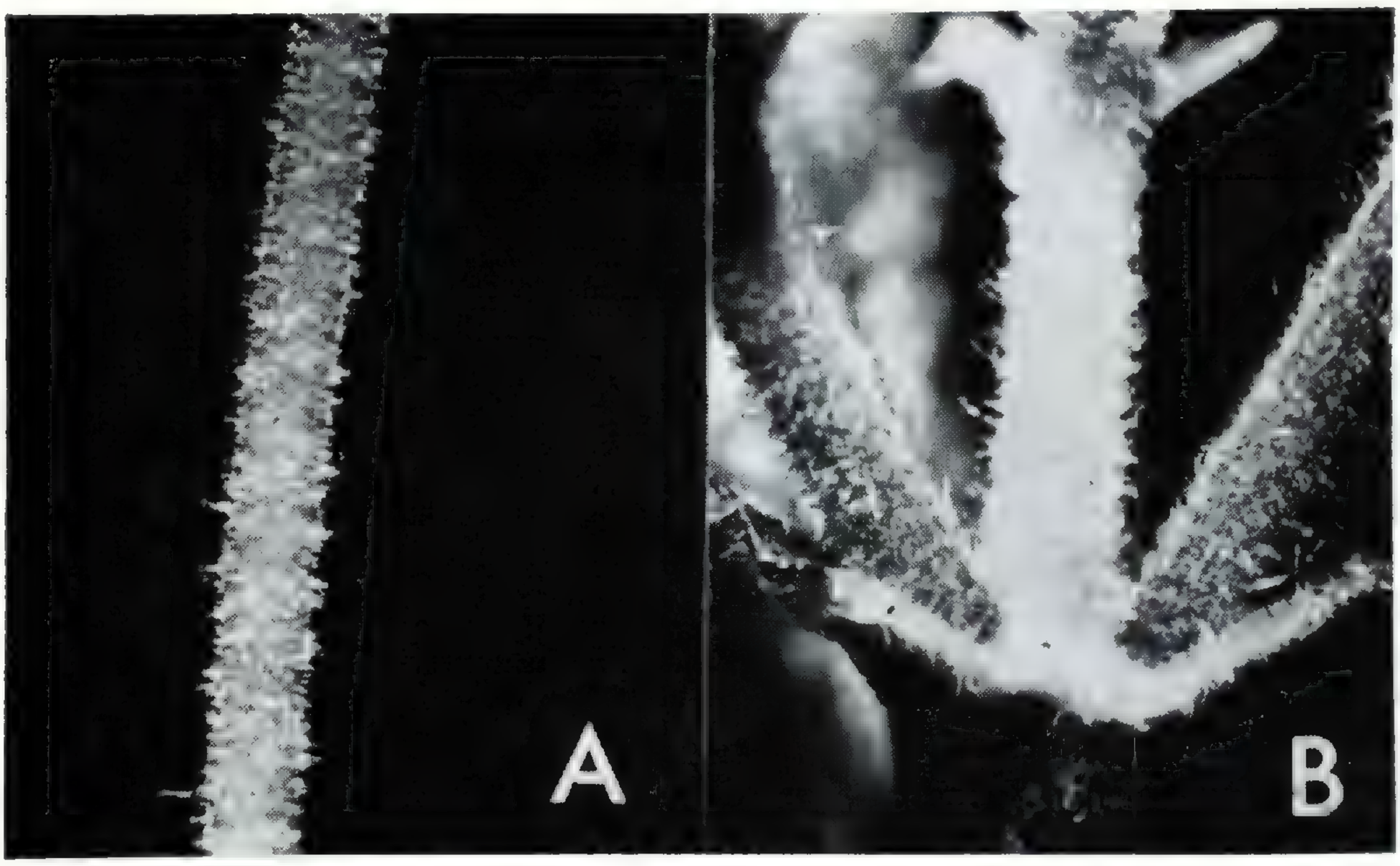
Table 2. SUMMARY OF BACKCROSSES AND CROSSES AMONG F_1 PLANTS

Pollen Parent (Variety)	Ovule Parent (Variety)	Crosses Attempted	Fruits Formed	
			No.	Percent
flor x *uve*	*uve*	39	6	15
flor x *uve*	*flor*	100	35	35
flor x *uve*	*flor*^{B}	84	64	76
		Total 223	105	47
dens x *uve*	*uve*	7	3	43
dens x *uve*	*dens*	59	25	42
uve x *dens*	*dens*	25	15	60
		Total 91	43	47
		Total 314	148	47
dens x *uve*	*dens* x *uve*	22	10	45
uve x *dens*	*dens* x *uve*	7	3	43
dens x *uve*	*uve* x *dens*	28	5	18
		Total 57	18	32
flor^B x *uve*	*flor*^{B} x *uve*	25	11	44
flor^B x *uve*	*uve* x *flor*^{B}	41	28	68
uve x flor^B	*uve* x *flor*^{B}	8	7	88
uve x *flor*^{B}	flor^B x uve	39	26	67
		Total 113	72	64
		Total 170	90	53

ent (Table 2) show substantially higher percentages of fruits formed when *floridana* from Bermuda was the ovule parent than was obtained by employing its United States counterpart as the ovule parent. This is in agreement with data from the corresponding crosses in Table 1, again pointing up the unique genotype of the *floridana* plant from the United States.

The percentages of fruits formed from crosses involving F_1 plants (Table 2) are sufficiently high that only slight reduction in fertility, if any, is indicated for the second generation. The F_2 seeds germinated readily but more than half of them did not flower. A suggestion of genetic incompatability due to excessive homogeneity is obtained via 6 albino seedlings which appeared in the F_2 generation. These 6 seedlings resulted from crosses involving all varieties.

What then is the mode of inheritance of the varietal char-



Pl. 1413. Peduncle vestiture variation from the same plant. A = var. *uvedalia* while B lies between vars. *floridana* and *densipilis*.

acters? An examination of the data in Table 3 shows that offspring may resemble either parent or may be "intermediate." It is well to keep in mind that more than one category of intermediacy may obtain but a detailed pubescence measurement per unit area not only would be impractical but meaningless because peduncle vestiture may vary altitudinally on the same plant. For purposes of this study I arbitrarily used the uppermost 1 cm of peduncle vestiture to characterize each plant. Pilose hairs may be longer or shorter in offspring than in parents. Glandular hairs vary likewise but independently. Although plants in culture for 6 years have maintained their varietal integrity, the photographs below are of two "good" varieties from different peduncles of the *same* plant (Pl. 1413). The Fig. A would key out to var. *uvedalia*, while B lies between var. *densipilis* and *floridana*. Other similar cases were observed.

Thus, although some genetic basis for varietal traits is adequately demonstrated (Table 3) there is likewise evidence for environmental influences upon phenotypic expression. One might also hypothesize highly mutable gene(s)

Table 3. PHENOTYPES OF F_1, F_2, AND BACKCROSS PLANTS.

Pollen Parent (Variety)	Ovule Parent (Variety)	Peduncle Vestiture Type			Total
		Like Pollen Parent	Intermediate	Like Ovule Parent	
flor^B	*uve*	0	7	1	8
uve	*flor*^{B}	3	2	1	6
flor	*uve*	3	3	2	8
uve	*flor*	0	1	2	3
uve	*dens*	1	2	0	3
dens	*uve*	0	2	11	13
uve x *flor*^{B}	*uve* x *flor*^{B}	0	1	0	1
dens x *uve*	*dens* x *uve*	0	1	0	1
uve x *flor*^{B}	*flor*^{B} x*uve*	2 like var. *uve*	6	0	8
flor^B x *uve*	*flor*^{B} x *uve*	0	1	0	1
flor^B x *uve*	*uve* x *flor*^{B}	1	1	0	2
flor^B x *uve*	*flor*^{B}	0	13	0	13

causing such a phenotypic aggregation. With respect to *P. uvedalia* Blake (1917) points out that "On the Bermuda Islands . . . it is certainly introduced and seems to be rapidly naturalizing itself. The plant is not noticed in Reade's list of Bermuda plants (1883), and as it is unlikely that so conspicuous a plant could have escaped his notice, it seems very probable that it is a recent introduction." Owing to the tendency for individual varietal distributions to occur in different parts of the United States it is unlikely that more than one variety was originally introduced there although all three are recorded from there now. The var. *floridana* is a likely candidate for the species' first establishment since its range of distribution includes portions of the United States closest to Bermuda. (North Carolina is some 568 miles distant.) Moreover, this variety is approximately 20% self-fertile, which is the highest incidence reported (Wells 1966) among the three varieties. Outbreeding from a single var. *floridana* introduction could have produced the present range of phenotypes.

Future comments upon peduncle vestiture in *P. uvedalia* must take into account the following facts:

1) Two types of pubescence obtain; namely, stipitate glandular hairs and pilose hairs.
2) The two hair types appear to vary independently in size and in frequency.
3) Results from some crosses suggest a quantitative inheritance of peduncle vestiture although other crosses indicate a simple dominant-recessive relationship.
4) Individual peduncle vestiture often varies from the proximal to distal regions.
5) Environmentally induced variation is possible as indicated by the different vestiture types "varieties" observed on peduncles of the same plant.

In view of all the facts, little usefulness is realized in continued recognition of the three varieties of *P. uvedalia* according to Blake (1917). What is true for *P. uvedalia* likewise probably holds for the closely related *P. maculata* from Mexico and Central America which Blake treated similarly.

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IRIS VERNA L.: LECTOTYPE AND VARIETY DESCRIPTION[1]

MAURICE E. EDWARDS[2]

Linnaeus (1753) in his description of *Iris verna* did not specify a plant specimen. Instead, he cited two documentary references, (1) Gronovius' *Flora Virginica* (1739), which cited a single specimen collected by John Clayton in Virginia, and (2) Plukenet's *Almagestum Botanicum* (1696), which recognized material collected by John Banister and also referred to an earlier work of Plukenet, *Phytographia* (1691), containing the first known reference to *I. verna*. Consequently a holotype is not absolutely discernible from the original Linnaean publication.

Since Linnaeus is known to have assisted Gronovius in the preparation of *Flora Virginica*, many Clayton specimens cited in that work are today recognized as Linnaean types (Fernald, 1940). Adding to this the idea that Linnaeus utilized *Flora Virginica* in the preparation of *Species Plantarum*, it is only reasonable to favor the Clayton specimen when selecting the type for the species.

However, while examining specimens on loan from 31 herbaria in the United States, an instance was noticed where photographs of Linnaean herbarium specimens, including one specimen probably misidentified as *I. verna* and with duplicate photographs deposited in two herbaria, had been mistakenly labelled as types. The circulated photographs do not resemble an *I. verna*. Moreover, Dykes (1913) in his monograph of *Iris* had stated that the Linnaean herbarium specimen of this species was incorrectly identified and was

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[1]This article results from literature and herbarium research for a Master of Arts thesis directed by Dr. R. B. Channell (Chairman, Department of General Biology, Vanderbilt University, Nashville, Tennessee), whom the author wishes to acknowledge for his suggestion of the problem and assistance throughout the study.

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probably an *I. prismatica* Pursh, which the circulated photographs resemble.

The Clayton specimen, as first suspected from photographs and later confirmed by written communication from Dr. William T. Stearn of the British Museum, does not possess rhizomes, which are critical to the identification of the two currently recognized taxa — var. *verna* (coastal element) and var. *Smalliana* (montane element). John Clayton is known to have collected extensively in the Coastal Plain of Virginia where the coastal element of *I. verna* grows. He is also known to have collected in other physiographic provinces of the state where the montane element grows, including the Blue Ridge and Shenandoah Valley (Fernald, 1940). Therefore, the actual source in Virginia of the Clayton specimen is to some degree questionable.

In the absence of compelling evidence to the contrary it seems appropriate to associate the Clayton specimen with the coastal form of variation, as initially was done by Small (1929) and presumably also by Fernald (1947). To avoid possible future confusion Clayton's specimen 253 of *Iris verna* is hereby designated the lectotype of the species. It is preserved in Herbarium Gronovius, British Museum (Natural History).

Iris verna, distributed between Pennsylvania and the Gulf Coast, consists of at least two geographical varieties, described by Small (1929, 1931) as mountain and coastal forms. Later the montane element was proposed by Fernald (1947) as a new taxonomic variety, but Fernald inadvertently failed to provide a Latin diagnosis when he proposed *I. verna* var. *Smalliana*, and thus technically the varietal name of the taxon is considered invalid. Therefore, to fulfill the requirements of Article 36 of the *International Code of Botanical Nomenclature* (Lanjouw, 1966) the following Latin description is presented.

Iris verna L. var. **Smalliana** Fern. var. nov. Iris vernalis pumila; corolla imberbis; odor nullus aut minor quam in typica; internodia brevia et radices multae secundum rhizoma; folia fere longiora et latiora quam in typica.[3] *Iris*

verna L. var. *Smalliana* Fern. in Rhodora 49: 214-215 (1947), *nom. nud.* and *I. verna*, (Mountain Form) Small in Addisonia 14: 15, *plate 456* (1929). (GH — type, locally abundant in the oak barrens, east of Crossville, Cumberland County, Tennessee, *Svenson 7635*, 2 May 1936; Isotypes — BKL, TENN.)

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[3]The author wishes to acknowledge Dr. F. L. Newton (Classical Studies Department, Vanderbilt University) for his correction of the Latin diagnosis.

THE VASCULAR FLORA OF OKLAHOMA — ADDITIONS AND COMMENTS

R. John Taylor and Constance Taylor

By the last of February, a number of plants may be found in flower or fruit in the United States south of the 36° north latitude, especially in the central and eastern portions. Few botanists, however, care to go afield when they must go encumbered by sufficient clothing to ward off the sharp wind and cold, wet ground of late winter or early spring. We began field work this spring (1968) the last two weeks in February. This proved very rewarding and thoroughly enjoyable, especially after a particularly wet, dreary fall and winter. Starting collections in the early part of the growing season has at least two advantages: (1) Very small plants may be seen at this time before the major plant cover has developed. Some small annual plants bloom and produce fruit only in the early part of the growing season and then are gone; others continue to flower into summer, but being covered by larger plants are seldom found and are sometimes missed entirely. (2) One may also gain a new and broader perspective of the flora. Some early flowering plants have one growth form at this time; but, later flowering specimens may look entirely different. It may be that, in some cases, different seasonal ecotypes comprise populations that continually flower throughout much of a growing season. Occasionally, specimens of the early flowering forms are encountered in a folder composed mainly of specimens collected later in the growing season. They are usually ignored as atypical and not representative, when indeed they are quite typical of one flowering form of the species.

This report is based mainly on the results of our field work in 1968. Five of the following species are reported as new to the Oklahoma flora and are marked with an asterisk. All specimens cited were collected by John and Connie

Taylor and are deposited at the Bebb Herbarium, Norman, Oklahoma, with duplicates of most deposited at SMU, Dallas, Texas.

Ophioglossum crotalophoroides Walt. This diminutive member of the Adder's-tongue ferns was recently reported as new to the Oklahoma flora from Bryan County (Taylor and Taylor 1967). From herbarium material and literature available, it might be concluded that this species is rare. Our observations this spring indicate this is not so. It was found in many sandy, overgrazed pastures throughout the northwestern portion of the Old Gulf Coastal Plain. Probably, because of its very small size and early fruiting, it is often overlooked. Fruiting specimens were found in Bryan County as early as February 10 and no later than May 1.

We now have additional specimens from the following sites in OKLAHOMA: ATOKA Co., *4811*, 5 mi. ne of COLEMAN; CHOCTAW Co., *4795*, 2 mi. w of BOSWELL; JOHNSTON Co., *4814*, 3 mi. e, 1 mi. s of FILLMORE; MARSHALL Co., *4855*, 2 mi. w, 4.5 mi. s of KINGSTON; MCCURTAIN Co., *4881*, 8 mi. w of IDABEL and *4864*, 1.5 mi. w of VALLIANT. Specimens were also collected from the following locations in TEXAS: BOWIE Co., *4842*, 1.25 mi. w of DEKALB; FANNIN Co., *4832*, 2 mi. ne of IVANHOE; LAMAR Co., *4833*, 4 mi. ne of DIRECT; RED RIVER Co., *4838*, 1 mi. e of WOODLAND.

**Ophioglossum vulgatum* L. This larger member of the Adder's-tongue ferns has been reported from a number of Texas counties including Denton, from Hempstead Co., Arkansas, and from Crawford Co., Kansas (Clausen 1938, Correll 1956). An Adder's-tongue fern was collected from a number of swampy areas and wet sandy bottomlands in Oklahoma and Texas this spring. These specimens proved to be *O. vulgatum*. This species usually has a much wider sterile blade and its rounded tip always lacks the apiculate tip of *O. engelmanni*, which it somewhat resembles. The veins of *O. engelmanni* form large areoles inclosing smaller ones; *O. vulgatum* lacks this characteristic. Likewise *O. engelmanni* is almost always found in limestone or tight clay soils in this area, while *O. vulgatum* occurs in sandy, wet bottoms. Its fruiting fronds can be found as much as three weeks earlier.

We have the following collections from OKLAHOMA: BRYAN CO., *4829*, 4.5 mi. e of BENNINGTON, and *4846*, 2 mi. w, 2.5 mi. n of OBERLIN; CHOCTAW CO., *4875*, 4 mi. n of SAWYER; MCCURTAIN CO., *4897*, 2 mi. n of VALLIANT; PUSHMATAHA CO., *4877*, 1.5 mi. s of OLETA. TEXAS locations are: LAMAR CO., *4837*, 1.5 mi. w of FAULKNER; RED RIVER CO., *4841*, 1.5 mi. e of WOODLAND.

**Lepuropetalon spathulatum* (Muhl.) Ell. This very small member of the Saxifragaceae has been reported as close to Oklahoma as Kaufman Co., Texas (Shinners, 1958). Flowering specimens of this species were found in Bryan Co., Oklahoma in mid-February. By the last of April, it could not be located in any of the areas from which it had been previously collected. It is usually common, sometimes abundant, where it is found — in sandy overgrazed pastures, old fields, and along roadsides. It is probably quite abundant and wide spread throughout its range, but is seldom collected because of its early flowering date and minute size. All of our specimens had only five stamens instead of the reported ten. All collections listed below were collected from soils derived from sandstone formations.

OKLAHOMA locations are as follows: ATOKA CO., *4810*, 5 mi. ne of COLEMAN; BRYAN CO., *4803*, overgrazed pasture on northwest edge of DURANT; CHOCTAW CO., *4863*, 2 mi. w. of BOSWELL; JOHNSTON CO., *4813*, 3 mi. e, 1 mi. s of FILLMORE; MARSHALL CO., *4856*, 2 mi. w, 4.5 mi. s of KINGSTON; MCCURTAIN CO., *4886*, 2 mi. n of the Little River; PUSHMATAHA CO., *4880*, 2.5 mi. e of OLETA. We also have specimens from the following TEXAS locations: BOWIE CO., *4843*, 1.25 mi. w of DEKALB; FANNIN CO,. *4831*, 2 mi. ne of IVANHOE; GRAYSON CO., *4835*, 2.5 m. e of DENISON; LAMAR CO., *4834*, 4 mi. ne of DIRECT; RED RIVER CO., *4839*, 1.5 mi. e of WOODLAND.

**Schrankia occidentalis* (W & S) Standl. Turner (1959) lists the range of this species of sensitive briar as the lower panhandle of Texas, occurring as far north as Crosby County. Our specimen *3868* was collected in the spring of 1967 from along U.S. 287, 3 miles north of the Oklahoma-Texas boundary in Cimarron County. Leaflets of our material are smooth and lack the pronounced veination of *S. uncinata*, the other species known from this area.

Epilobium glandulosum Lehm. var. *adenocaulon* (Haussk.) Fern. was reported as new to the Oklahoma flora

by Taylor and Taylor (1967). The specimens on which the report was based came from an isolated population in a branch of Tessequite Canyon in extreme western Cimarron County. Abundant material of this species has been subsequently collected from a canyon 16 miles N and 2 miles W of Boise City in northcentral Cimarron County.

**Verbena brasiliensis* Vell. Specimens of this South American adventive were collected from a roadside ditch about three-fourths of a mile NE of the small Johnston Co. community of Troy, Oklahoma. Gleason (1963) gives its range in this area as Arkansas and Louisiana and Gould (1962) lists it from Texas. It differs from a similar species, *V. bonariensis*, known to the Oklahoma flora, by absence of sessile amplexicaulate leaves. Our material has very narrow petioles, which sometimes may have a very thin margin along the basal portions. Spikes tend to be less compact, narrower, and a little longer than those of *V. bonariensis*.

Hedyotis rosea Raf. was reported to the Oklahoma flora from northeast and north central Oklahoma by Waterfall (1953). His Keys to the Flora of Oklahoma (1966) lists it from a number of scattered locations in the same general area. We have seen Bebb Herbarium specimens from Cleveland County, and collected it in Johnston County during the spring of 1963. Collections this spring added specimens from Bryan, Marshall, McCurtain, and Pushmataha Counties, indicating this plant grows throughout the eastern half of Oklahoma. It is often found with the ubiquitous *H. crassifolia*, but no intermediates were observed. Although *H. crassifolia* is rather variable in this area in flower color, flower size, as well as other characteristics, *H. rosea* is easily distinguished where the two occur together. From our observations, it seems that *H. rosea* is never as abundant, begins to flower slightly later, completes flowering sooner, and tends to favor habitats with slightly different edaphic conditions than *H. crassifolia* where they occur in the same area. It may be that a mechanism similar to that described by Lewis and Moore (1959) for *H. australis* is also involved in *H. rosea*.

**Aster brachyactis* Blake. Specimens of this western aster were collected 7 miles east of Kenton on Willow Creek, in western Cimarron Co., on Oct. 4, 1964. The material had been grazed by stock, thus was short and somewhat atypical in growth form. Dr. G. J. Goodman was kind enough to identify our *2552*. It does not appear to have previously been reported for our Oklahoma flora.

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THE BROMELIACEAE OF BOLIVIA

LYMAN B. SMITH

Continued from page 57

2. **Fosterella** L. B. Smith

Terrestrial, ombrophilous, stemless. Leaves rosulate, entire or serrulate, the blades more or less narrowed toward base. Scape erect, elongate. Inflorescence usually laxly paniculate, often tripinnate. Flowers small, homomorphic, perfect. Sepals free. Petals free, naked much exceeding the sepals, usually white. Stamens of the inner series very short-adnate to the base of the petals, the anthers linear, basifixed, the pollen dry, wind-borne. Ovary wholly superior, glabrous, the placentae elongate, the style very slender. Capsule septicidal or loculicidal. Seeds bicaudate.

a. Flowers neither secund nor nutant; inflorescence amply tripinnate.
  b. Stamens longer than the petals; leaf-blades 8 mm. wide. ..... 1. *F. Pearcei.*
  b. Stamens shorter than the petals; leaf-blades 20-30 mm. wide, serrulate toward base. ..... 2. *F. albicans.*

a. Flowers secund or nutant, usually both.
  c. Leaf-blades serrulate, at least toward base.
    d. Leaf-blades serrulate for most of their length, pungent; scape-bracts serrulate; flowers 5 mm. long. ..... 3. *F. Weddelliana.*
    d. Leaf-blades serrulate only toward base, filiform-acuminate; scape-bracts entire; flowers 3 mm. long.
      e. Scape-bracts bladeless; leaf-blades flat, uniform. ..... 4. *F. Rusbyi.*
      e. Scape-bracts with large foliaceous blades; leaf-blades channeled. ..... 5. *F. graminea.*
  c. Leaf-blades entire.
    f. Inflorescence densely villous; floral bracts more than twice as long as the pedicels, acuminate. ..... 6. *F. villosula.*
    f. Inflorescence glabrous; floral bracts merely acute, mostly shorter than the pedicels.
      g. Flowers 5 mm. long; sepals subtriangular. ..... 7. *F. schidosperma.*
      g. Flowers 8-9 mm. long.
        h. Sepals obtuse; leaves to 25 cm. long. .... 8. *F. penduliflora.*
        h. Sepals acute; leaves about 15 cm. long. ..... 9. *F. gracilis.*

1. **Fosterella Pearcei** (Baker) L. B. Smith in Phytologia, **7:** 172 (1960). *Lindmania Pearcei* (Baker) Mez of Catalogue. Flowering to 5 dm. high. Leaf-blades linear, narrowed toward base, caudate-

attenuate, 8 mm. wide, channeled, covered beneath with pale appressed scales, glabrous above. Scape erect. Scape-bracts strict, densely imbricate, subfoliaceous. Inflorescence laxly tripinnate, subthyrsoid, attenuate, 4 dm. long, arachnoid. Primary bracts linear-triangular, attenuate, shorter than the sterile bases of the branches. Branches ascending, lax. Floral bracts triangular-ovate, exceeding the pedicels, the upper 3.5 mm. long. Flowers erect or suberect, not notably secund, 3.5 mm. long. Sepals semiorbicular, broadly rounded, 2 mm. long. Petals slightly exceeding the sepals. Stamens exserted, the anthers 2 mm. long. DEPARTMENT UNKNOWN: Butuco, 1865, *Pearce* s. n. (BM; type). LA PAZ: SUR YUNGAS: Basin of Rio Bopi, San Bartolome near Calisaya, 750-900 m., *Krukoff* 10328 (GH, NY).

2. **F. albicans** (Griseb.) L. B. Smith in Phytologia 7: 171 (1960). Flowering 8-10 dm. high. Leaf-blades linear, soft-acuminate, narrowed and serrulate toward base, 20-30 mm. wide, cinereous-lepidote especially beneath. Scape erect, 7 mm. in diameter. Scape-bracts subfoliaceous, much exceeding the internodes, entire. Inflorescence tripinnate, thyrsoid, to 4 dm. long, pale-lepidote. Primary bracts narrowly triangular, shorter than the branches. Branches divergent, subdensely 10-20-flowered. Floral bracts broadly ovate, acuminate, 4-5 mm. long, slightly exceeded by the sepals. Pedicels 1.5 mm. long. Flowers spreading, not secund. Sepals ovate, subobtuse, 4 mm. long. Petals 5.5 mm. long. COCHABAMBA: CHAPARE: Sacaba, *Steinbach* 5699 (LIL). Argentina.

3. **F. Weddelliana** (Brongn. ex. Baker) L. B. Smith in Phytologia, 7: 172 (1960). *Lindmania Weddelliana* (Brongn.) Mez of Catalogue. Flowering 5 dm high. Leaf-blades ligulate, narrowed to a pungent apex, somewhat constricted at base, ca. 16 cm. long, 20 mm. wide, serrate at least at base with spines 0.5 mm. long, brown-lepidote especially beneath. Scape slender, glabrous. Scape-bracts imbricate, serrulate. Inflorescence laxly tripinnate, 20 cm. long, glabrous. Primary bracts narrowly triangular, caudate-attenuate, much shorter than the branches. Branches erect, very slender, sublaxly 15-30-flowered. Floral bracts suberect, broadly elliptic, short-acuminate, hyaline, the upper 2 mm. long. Pedicels slender, exceeding the floral bracts. Flowers secund, nutant, 5 mm. long. Sepals ovate-elliptic, broadly rounded, 2 mm. long. Petals white, exceeding the stamens. LA PAZ: Yungas, *Weddell* 4233 (P; type).

4. **F. Rusbyi** (Mez) L. B. Smith in Phytologia, 7: 172 (1960). *Lindmania Rusbyi* Mez of Catalogue. Flowering 5 dm. high. Leaf-blades linear, attenuate to a soft filiform apex, slightly narrowed toward base, 2 dm. long, somewhat dimorphic with broad and narrow forms, to 25 mm. wide, chartaceous-membranaceous, sparsely serrulate at base, pale green and glabrate above, covered beneath with a

membrane of whitish scales. Scape erect, slender, glabrous. Scape-bracts lanceolate, filiform-attenuate, longer or shorter than the internodes, entire. Inflorescence laxly 2-3-pinnate, 3 dm. long, the axes glabrous. Primary bracts like the scape-bracts, much shorter than the branches. Branches curved-ascending, elongate very slender, laxly 8-15-flowered. Floral bracts broadly ovate, acute, minute, membranaceous. Flowers nutant, secund 3 mm. long. Sepals ovate-elliptic, rounded, 1.5 mm. long. Petals greenish. Stamens included. LA PAZ: Yungas, *Bang* 2571 (B; type; BM, F, G, GH, K, NY, US); NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 3674 (NY, US); Milluguaya, 1300 m., *Buchtien* 4285 (US). Peru.

5. **F. graminea** (L. B. Smith) L. B. Smith in Phytologia, **7**: 171 (1960). *Lindmania graminea* L. B. Smith of Catalogue. Flowering over 1 m. high. Leaf-blades linear, filiform-attenuate, contracted at base but not really petiolate, 6 dm. long, 12 mm. wide, strongly channeled, subdensely serrate toward base with spines 1 mm. long, glabrous above, covered beneath with a membrane of white scales. Scape erect, elongate, slightly flexuous, 5 mm. in diameter, glabrous. Scape-bracts very large but spreading and not concealing the scape, entire, the lowest foliaceous with small sheaths, the highest filiform-attenuate from a very narrowly triangular base. Inflorescence laxly and very amply tripinnate, over 6 dm. long, glabrous. Lowest primary bracts like the top scape-bracts, large but shorter than the branches, the highest greatly reduced. Branches curved upward, laxly secund-flowered. Floral bracts broadly elliptic, less than half as long as the pedicels. Pedicels slender, 2 mm. long. Sepals elliptic, obtuse, 1.5 mm. long. Petals 3 mm. long, equaling the stamens, white. LA PAZ: LARECAJA: Mapiri, San Carlos, 700 m., *Buchtien* 417 (US; type).

6. **F. villosula** (Harms) L. B. Smith in Phytologia, **7**: 172 (1960). *Lindmania villosula* Harms of Catalogue. Propagating by basal offshoots, flowering over 6 dm. high. Leaves few, rosulate, 2-3 dm. long, entire, membranaceous, the blades linear-lanceolate, attenuate, narrowed toward base, 25-40 mm. wide, sparsely flocculose beneath, glabrous above. Scape erect, flocculose. Scape-bracts densely imbricate, linear-lanceolate, attenuate, 3-5 cm. long, thin. Inflorescence laxly subtripinnate, subcylindric, 25 cm. long, many-flowered, flocculose-villous. Primary bracts like the scape-bracts, 2-4 cm. long. Branches curved-ascending, subdense. Floral bracts lance-ovate, attenuate, nearly 7 mm. long. Pedicels very short. Flowers nutant, secund. Sepals oblong-ovate, subacute, 4-5 mm. long. Petals broadly oblanceolate, subobtuse, 7 mm. long. Stamens included. LA PAZ: SUR YUNGAS [?]: Beni River Valley, 1000 m., *Rusby* 393 (NY); COCHABAMBA: CHAPARE: Incachaca to San Antonio, 1600 m., *Werdermann* 2120 (B; type).

7. **F. schidosperma** (Baker) L. B. Smith in Phytologia, 8: 500 (1963). *Cottendorfia Rusbyi* Baker in Bull. Torr. Bot. Club, 29: 697 (1902). *Lindmania Weberbaueri* Mez of Catalogue. Flowering 9 dm. high. Leaf-blades broadly lanceolate, attenuate, narrowed toward base, 25 cm. long, 4 cm. wide, entire, membranaceous, glabrous. Scape erect, slender, glabrous. Scape-bracts ovate, attenuate, shorter than the internodes, entire. Inflorescence laxly bipinnate, 3 dm. long, 75 mm. wide, many-flowered, glabrous. Primary bracts like the scape-bracts, many times shorter than the branches. Branches curved-ascending, 8 cm. long, lax. Floral bracts ovate, acute, 1.5 mm. long, shorter than the pedicels, erect. Flowers nutant, rather obscurely secund, 5 mm. long. Sepals subtriangular, obtuse, 2.5 mm. long. Petals subelliptic, acute, erect at anthesis. Stamens included. LA PAZ: Yungas, 2000 m., *Rusby* 2541 (NY; type of *Cottendorfia Rusbyi* Baker; US); SUR YUNGAS: Rio Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10482 (GH, US). Peru.

8. **F. penduliflora** (C. H. Wright) L. B. Smith in Phytologia, 7: 172 (1960). *Lindmania penduliflora* (C. H. Wright) Stapf of Catalogue. Flowering 25-60 cm. high, propagating by suckers. Leaf-blades linear-lanceolate with a soft narrow apex, 35 cm. long, 35 mm. wide, thin, glabrous above, sparingly scurfy beneath. Scape slender, glabrous. Scape-bracts lanceolate, attenuate, entire, the upper remote. Inflorescence laxly paniculate, 2 dm. long, glabrous. Primary bracts like the upper scape-bracts, 5-10 mm. long, hyaline. Branches simple or the lowest divided and 2 dm. long, laxly many-flowered. Floral bracts ovate, acuminate, 1-1.5 mm. long, thin, green. Pedicels slender, 2, rarely 3, mm. long. Sepals lanceolate, obtuse, 3.5 mm. long, green with white margins. Petals lance-oblong, 8-9 mm. long, over 2 mm. wide, white. Stamens included. SANTA CRUZ: CORDILLERA: Lagunillas, Cordillera of Cara, 1200 m., *Cárdenas* 2856 (GH); CHIQUITOS: Robore, 416 m., *Cárdenas* 2994 (GH). Peru, Argentina.

9. **F. gracilis** (Rusby) L. B. Smith in Phytologia, 7: 171 (1960). *Catopsis gracilis* Rusby in Bull. N. Y. Bot. Gard. 6: 489 (1910). *Lindmania gracilis* (Rusby) L. B. Smith of Catalogue. Flowering 30-45 cm. high. Leaves few, 15 cm. long, entire, the outer ones white-tomentose-lepidote, the blades linear-lanceolate, attenuate, narrowed toward base, 11 mm. wide. Scape erect, slender. Scape-bracts narrowly triangular, attenuate, much shorter than the internodes. Inflorescence laxly bipinnate or subtripinnate. Primary bracts like the scape-bracts, shorter than the sterile bases of the branches. Branches curved-ascending, very slender, sublaxly many-flowered. Floral bracts ovate, acute, shorter than the pedicels. Pedicels slender, 3 mm. long. Flowers nutant, secund. Sepals ovate, acute, 2 mm. long. Petals lanceolate, 5-6 mm. long, equaling the stamens. LA PAZ: SUR YUNGAS:

Guanai, 500 m., *R. S. Williams* 738 (NY; type); Santa Ana, Bopi, 500 m., *White* 1086 (NY).

3. **Deuterocohnia** Mez

Spreading shrubs. Leaves many, densely rosulate, the blades narrowly triangular, usually spinose-serrate. Scape woody with a distinct cambium layer. Inflorescence perennial, putting forth new branches from buds on the axis every year, 2-4-pinnate. Branches polystichous-flowered, surrounded by buds at the base. Flowers sessile or very short-pedicellate. Sepals free. Petals free, actinomorphic, erect, much exceeding the sepals, bearing a single large incised scale at the base. Stamens free, the anthers linear, dorsifixed, the pollen sulcate. Ovary superior, glabrous, the placentae linear. Ovules numerous, bearing a narrow dorsal wing that is more or less produced at the apex. Capsule septicidal to the base. Seeds winged.

Branches of the inflorescence laxly flowered, the rhachis almost wholly exposed. ..... 1. *D. longipetala.*
Branches of the inflorescence strobilate, the rhachis completely covered. ..... 2. *D. strobilifera.*

1. **Deuterocohnia longipetala** (Baker) Mez in Mart. Fl. Bras. 3(3): 506 (1894). Flowering 8-10 dm. high. Leaf-blades 3-4 dm. long, attenuate to a slender caudate entire apex, covered with white transparent scales and beneath with cinereous opaque ones, densely serrate with spines 3-4 mm. long. Scape 5-6 mm. in diameter, glabrous. Scape-bracts linear-triangular, serrate, the upper shorter than the internodes. Inflorescence laxly paniculate, many-flowered, the axes subferruginous-tomentellous or glabrous. Primary bracts minute, about equaling the buds. Branches spreading, slender, simple or compound, 10-20 cm. long. Floral bracts very broadly ovate, apiculate, 4 mm. long. Flowers erect, sessile, 17-25 mm. long. Sepals strongly asymmetric, ovate, obliquely truncate, 8-10 mm. long, few-nerved. Petals yellow with a green spot at apex, equaling or exceeding the stamens. Anthers 4-6 mm. long, green. SANTA CRUZ: CERCADO [?]: Sierra de Santa Cruz, 2000 m., *Kuntze* s. n. (NY); Comarapa to Vallegrande, 2100 m., *Cárdenas* 4007 (US); CORDILLERA: Tareira, Lagunillas, 1000 m., *Cárdenas* 2850 (GH). Peru, Argentina.

2. **D. strobilifera** Mez in Fedde, Repert. Spec. Nov. 3: 15 (1906). Forming loose polsters, the flowering shoot 15-20 cm. high. Leaf-blades 10-20 cm. long, 18 mm. wide, covered with a whitish or silvery coat of scales, laxly serrate in the typical variety with curved subspreading spines 5 mm. long. Scape 6-15 cm. long. Scape-bracts foliaceous, exceeding the internodes. Inflorescence laxly bipinnate from a few branches. Spikes sessile, ellipsoid, obtuse, strobilate, 3-5 cm. long, 18 mm. in diameter. Floral bracts ovate, acute, 7 mm. long, about equaling the sepals. Flowers sessile or subsessile, very

variable in size, glabrous. Sepals broadly elliptic, somewhat asymmetric, 6-9 mm. long, mucronulate. Petals elliptic-oblong, 15 mm. long, yellow, the basal scale more or less bifurcate. Stamens equaling or exceeding the petals. CHUQUISACA: SUR CINTI: Camataquí, 2500 m., *Fiebrig* 2933 (B; type). Argentina.

2a. **D. strobilifera** var. **inermis** L. B. Smith in Contrib. U. S. Nat. Herb. 29: 535 (1954). Leaf-blades entire. POTOSÍ: SUR CHICHAS: Oploca to Atocha, 3000 m., *Cárdenas* 3741 (GH, US). CHUQUISACA: CINTI: Sivingamayu, 3400 m., *Cárdenas* 4094 (US; type). TARIJA: CERCADO: Villazón to Tarija, 3400 m., *West* 8379 (GH). Argentina.

4. **Abromeitiella** Mez

Abromeitiella brevifolia (Griseb.) Castellanos in Anal. Mus. Nac. Hist. Nat. Buenos Aires, **36**: 371, tt. 2, 3, 6 (1931). *Navia brevifolia* Griseb. Symb. Argent. in Goett. Abh. **24**: 332 (1879). Terrestrial polster-forming herbs with much branched dichotomous stems. Leaves densely rosulate at the ends of the branches, 22 mm. long, 7 mm. wide, 2.5 mm. thick, the blades narrowly triangular, fleshy, serrate, lepidote. Scape none. Inflorescence 1-3-flowered in the center of the rosette. Flowers sessile, 31 mm. long, green. Sepals free, more or less asymmetric, mucronulate, 10-13 mm. long, 6 mm. wide. Petals free, distinctly unguiculate, 30 mm. long, 7 mm. wide, bearing a single serrate 5 mm. scale at base. Stamens of the second series short-adnate to the petals, the pollen longitudinally sulcate. Style filiform. Ovary pyramidal, 5 mm. long, 3 mm. in diameter, the placentae extending the whole height of the locule. Capsule globose, 9 mm. in diameter, septicidal. Seeds fusiform, caudate at both ends. TARIJA: ARCE [?]: Valle del Tambo, *Lorentz & Hieronymus* 947 (GOET; type). Argentina.

5. **Pitcairnia** L'Hérit., nomen conservandum

Plants mostly terrestrial, rarely epiphytic, mostly stemless, but a few species definitely caulescent. Leaves fasciculate or imbricate and many-ranked along a stem, entire or spinose-serrate, the sheaths usually small, often bulbous-thickened, the blades linear to broadly elliptic with a definite petiole or narrowly triangular, sometimes dimorphic with some blades reduced to horny spinose-serrate spines, deciduous in some species. Scape usually developed. Inflorescence simple or compound. Flowers perfect, pedicellate to sessile. Sepals free, attenuate to obtuse. Petals free, slightly zygomorphic in most species, naked or appendaged on the inside near the base. Stamens from slightly exserted to shorter than the petals, anthers linear. Style filiform. Ovules many, caudate in all the Bolivian species. Fruit mostly a septicidal capsule. Seeds caudate at both ends.

a. Inflorescence branched (uncertain in *P. platystemon*).
b. Petals naked; sepals 20-22 mm. long.
c. Petals long-attenuate; pedicels 23 mm. long. ..... 1. *P. platystemon.*
c. Petals acute or obtuse, not attenuate; pedicels 9-15 mm. long.
d. Leaf-blades narrowed at base but not petiolate. ..... 2. *P. multiramosa.*
d. Leaf-blades distinctly petiolate.
e. Leaf-blades white-furfuraceous beneath; spines of petiole 3 mm. long. ..... 3. *P. odontopoda.*
e. Leaf-blades not conspicuously white beneath; spines of petiole 1.5 mm. long. ..... 4. *P. divaricata.*
b. Petals appendaged; sepals 11-18 mm. long.
f. Sepals attenuate; branches elongate. ..... 5. *P. paniculata.*
f. Sepals obtuse; branches abbreviated. ..... 6. *P. inermis.*
a. Inflorescence simple.
g. Floral bracts inconspicuous; inflorescence lax.
h. Petals naked; sepals 8-22 mm. long.
i. Pedicels 23 mm. long, exceeding the floral bracts; petals long-attenuate. ..... 1. *P. platystemon.*
i. Pedicels 6-15 mm. long.
j. Sepals 8 mm. long; leaf-blades persistent, 30-40 mm. wide. ..... 7. *P. Trianae.*
j. Sepals 18 mm. long; leaf-blades deciduous, 2 mm. wide. ..... 8. *P. Cardenasii.*
h. Petals appendaged; sepals 20-42 mm. long.
k. Sepals 42 mm. long, attenuate; flowers spreading to reflexed. ..... 9. *P. crassa.*
k. Sepals 20-30 mm. long, obtuse; flowers erect to subspreading. ..... 10. *P. lanuginosa.*
g. Floral bracts conspicuous, broad and more or less imbricate; inflorescence dense. ..... 11. *P. Brittoniana.*

1. **Pitcairnia platystemon** Mez in DC. Monog. Phan. **9**: 421 (1896). Leaves and scape unknown. Inflorescence possibly compound but known only from fragments 31-38 cm. long, glabrous. Axis more or less glaucous, sulcate, especially toward apex. Floral bracts broadly ovate, acuminate, recurved-spreading, 15-20 mm. long. Flowers erect. Pedicels very slender, to 23 mm. long. Sepals attenuate, uncinate-recurved, 22 mm. long, 4.5 mm. wide, ecarinate. Petals attenuate, 34 mm. long, yellow or green when dry, naked. Stamens included. Ovary over 1/2 superior. Ovules caudate. SANTA CRUZ: CHIQUITOS: Santiago, *d'Orbigny* 937 (P; type).

2. **P. multiramosa** Mez in DC. Monog. Phan. **9**: 419 (1896). Flowering 1 m. or higher. Leaves dimorphic, some reduced to narrowly ovate acute sheaths, covered with a thin quickly deciduous membrane of

white scales, others foliaceous, often over 1 m. long, the blades narrowly lanceolate, narrowed toward base but not petiolate, 35 mm. wide, submembranaceous when dry, minutely furfuraceous or glabrate beneath, serrate toward apex with green antrorse spines 1 mm. long. Scape erect, very stout, glabrous. Scape-bracts erect, lanceolate, attenuate, the upper shorter than the internodes. Inflorescence amply paniculate, 5 dm. long, many-flowered, subglabrous. Primary bracts narrowly triangular, shorter than the sterile basal 1/3 of the branches. Branches strict, to 25 cm. long. Floral bracts ovate-triangular, 5 mm. long. Flowers suberect. Pedicels very slender, 15 mm. long. Sepals attenuate, 22 mm. long, 4 mm. wide, slightly carinate at base, the margin pale and subscarious. Petals acute, 45 mm. long, red, naked. Stamens included. Ovary 3/4 superior. Ovules caudate. CHUQUISACA: AZERO: *Weddell* 3637 (P; type); Río Azero to Monteagudo, 1900 m., *Cárdenas* 5732 (US).

3. **P. odontopoda** Baker, Handbk. Bromel. 93 (1889). Flowering about 1 m. high. Leaves all persistent, dimorphic, the outer with very broadly elliptic dark sheaths covered with a membrane of brown scales and blades reduced to spinose-serrate spines, the inner foliaceous with elliptic sheaths, the petioles 30 cm. long, deeply channeled, serrate with dark antrorse spines 3 mm. long, the blades linear-lanceolate, attenuate, 22-26 mm. wide, entire, reddish beneath, glabrous at maturity. Scape about equaling the leaves, slender. Scape-bracts exceeding the internodes, narrowly triangular, filiform-attenuate, entire. Inflorescence paniculate, pyramidal, the axes white-tomentulose. Primary bracts narrowly triangular, many times shorter than the branches. Branches subspreading, straight, lax, the lateral 6-10 cm. long. Floral bracts ovate-elliptic, acuminate, 5 mm. long. Pedicels slender, 9-12 mm. long. Sepals subtriangular, acute, 20 mm. long, white-puberulent. Petals acute, 4 cm. long, red, naked. Ovary over 3/4 superior. Ovules caudate. LA PAZ: NOR YUNGAS: Coroico, 1500-2000 m., *Pearce* s. n. (K; type); SUR YUNGAS: Chirca, 2500 m., *Eyerdam* 25357 (F, UC).

4. **P. divaricata** Wittm. in Meded. Rijks Herbar. **29:** 81 (1916). Flowering over 8 dm. high. Leaves dimorphic or trimorphic, the median over 1 m. long with linear blades 2-3 cm. wide, the sheaths bulbous-imbricate, ovate, covered outside with a membrane of gray-fuscous scales, the petiole distinct, 20-25 cm. long, spinose-serrate, the blades 8-9 dm. long, broadly white-striate along the median nerve when dry, the innermost leaves reduced to broad sheaths with a spinose apex. Scape erect, stout, glabrous. Scape-bracts erect, the highest narrowly lanceolate, filiform-attenuate, shorter than the internodes, entire. Inflorescence amply paniculate, to 3 dm. long. Primary bracts narrowly triangular, much shorter than the sterile bases of the branches. Branches divaricate, to 13 cm. long, 4-9-flowered, slightly

glaucous-pruinose. Floral bracts ovate-elliptic, acuminate, about half as long as the pedicels. Pedicels slender, 10 mm. long. Sepals lanceolate, acuminate and recurved at apex, 20 mm. long, nearly or quite ecarinate, glabrous. Petals linear, subobtuse, to 5 cm. long, red, naked. Stamens included. Ovary about ½ inferior. Ovules caudate. SANTA CRUZ: CORDILLERA: Quebrada de Charagua, 900 m., *Herzog* 1212 (L; type; B).

5. **P. paniculata** (R. & P.) R. & P. Fl. Peruv. **3:** 36, t. 260 (1802). *P. biattenuata* Rusby in Bull. N. Y. Bot. Gard. **4:** 457 (1907). Flowering over 2 m. high. Stem erect, stout, ringed with leaf-scars. Leaves densely fasciculate, dimorphic or trimorphic, the outer reduced, scale-like or some with setiform spinose blades, the inner elongate, contracted above the sheath but not always petiolate, attenuate, to 1.5 m. long, 35 mm. broad, remotely spinulose-serrate, glabrous above, sparsely furfuraceous beneath. Scape white-furfuraceous. Scape-bracts narrowly triangular, filiform-caudate, the uppermost about equaling the internodes. Inflorescence laxly paniculate, pyramidal, 5 dm. or longer, the axis furfuraceous. Primary bracts narrowly triangular, mostly shorter than the sterile bases of the branches. Branches suberect to spreading, secundly many-flowered. Floral bracts lance-ovate, acute, much shorter than the 13 mm. long pedicels. Sepals narrowly triangular, attenuate, 15-18 mm. long. Petals 45 mm. long, red, appendaged. Stamens included. Ovary almost wholly superior. Ovules caudate. LA PAZ: MURILLO: La Paz to Hacienda Chaco, 1350 m., *M. B. Foster* 2576 (US); YUNGAS: Puente Villa, 1600 m., *Cárdenas* 3582 (GH); LARECAJA: Guanai to Tipuani, *Bang* 1352 (BM, GH, US); Tipuani, 1400 m., *Buchtien* 5349 (GH); NOR YUNGAS: Coripati, *Bang* 2155 (BM, G, GH, MICH, US). Peru.

6. **P. inermis** (Meyer in Presl) Meyer ex Schult. f. in R. & S. Syst. Veg. **7** (2): 1238 (1830). Stemless, to 5 dm. high. Leaves all alike, deciduous above the serrulate base, not at all contracted above the broadly ovate dark sheath; blade entire, linear, attenuate, 4-9 dm. long, 7-12 mm. wide, white-lepidote beneath. Scape stout, soon glabrous. Scape-bracts much exceeding the internodes, lance-ovate, entire, filiform-caudate. Inflorescence thyrsoid, its axis stout, soon glabrous. Primary bracts almost or quite equaling the short branches. Floral bracts scale-like, shorter than the slender 7 mm. long pedicels. Sepals obtuse, 11-15 mm. long, ecarinate. Petals 30-35 mm. long, scarlet, rapidly fading to white, appendaged. Stamens included. Ovary more than 3/4 superior. DEPARTMENT AND PROVINCE UNKNOWN: Coromillo, *Pearce* 521 (fide Mez, Pflanzenreich, iv. Fam. 32: 243, 244).

7. **P. Trianae** André, Énum. Bromél. 4 (Dec. 13, 1888); in Rev. Hortic. **60:** 564 (Dec. 16, 1888). Flowering to 2 m. high. Leaves

numerous, persistent, 12 dm. long, the blades linear, attenuate at both ends but not petiolate, 3-4 cm. wide, soon glabrous, spinose toward base. Scape very stout, at first white-arachnoid. Scape-bracts strict, very narrowly triangular, the lower spinose-serrate, the upper entire, shorter than the internodes. Inflorescence simple, many-flowered, very dense except near base, 3-5 dm. long, the axis straight, stout, arachnoid. Floral bracts triangular-ovate, mostly shorter than the pedicels. Flowers spreading to reflexed. Pedicels very slender, 15 mm. long. Sepals oblong, obtuse, 8 mm. long, ecarinate. Petals obtuse, to 45 mm. long, equaling the stamens, white or pale yellow, naked. Ovary at least 3/4 superior. Ovules short-caudate. LA PAZ: MURILLO [?]: Eastern slope of Eastern Cordillera, 1650 m. *M. B. Foster* 2574 (US). Ecuador, Colombia.

8. **P. cardenasii** L. B. Smith in Phytologia, 8: 505, t. 3, fig. 5-7 (1963). *P. rigida* of Catalogue, non Mez (1904). Reproducing vegetatively by scaly rhizomes, flowering 3-6 dm. high. Leaves forming bulbous rosettes that soon appear lateral by the elongation of the rhizome, entire, vestite with linear white subspreading scales, the sheaths broadly ovate, 2 cm. long, strongly nerved, castaneous toward base, the blades dimorphic, some persistent, reduced, broadly triangular, thin, stramineous, others deciduous along a straight transverse line, linear, attenuate, 10 cm. long (young), 2 mm. wide, fasciculate. Scape very slender, white-flocculose especially toward base. Scape-bracts erect, the lower imbricate, subfoliaceous and with deciduous blades, the upper narrowly triangular, shorter than the internodes. Inflorescence secundly racemose, red, sparsely white-flocculose. Floral bracts narrowly triangular, exceeding the slender 6-8 mm. long pedicels. Flowers suberect. Sepals oblong, acute, 18 mm. long, carinate at base. Petals rounded-apiculate, 45 mm. long, naked. Stamens included. Ovary 4/5 superior. Seeds caudate. SANTA CRUZ: VALLE GRANDE: Cuesta de Monos, 1000 m., *Cárdenas* 4648 (US; type).

9. **P. crassa** L. B. Smith in Lilloa, 14: 94 (1948). Leaves and scape unknown. Inflorescence simple, laxly many-flowered, glabrous with age, the axis 1 cm. in diameter, lightly sulcate. Floral bracts reflexed, broadly lanceolate, acute, 35 mm. long, exceeding the pedicels. Flowers spreading or reflexed. Pedicels 25 mm. long, 2 mm. in diameter, angled. Sepals narrowly triangular-lanceolate, 42 mm. long, carinate, nerved. Petals appendaged. Ovary 2/3 superior. Seeds caudate. LA PAZ: Yungas: Puente Villa, 1400 m., *Cárdenas* 3690 (GH; type).

10. **P. lanuginosa** R. & P. Fl. Peru. 3: 35, t. 258 (1802). *P. subpetiolata* Baker in Journ. Bot. 19: 267 (1881). *P. sessiliflora* Rusby in Bull. N. Y. Bot. Gard. 4: 457 (1907). Stemless, flowering 6-12 dm. high. Leaves persistent, dimorphic, the outer with broadly ovate

dark castaneous sheaths and reduced subulate spinose-serrate blades, the inner to over 1 m. long with the blades ensiform, fiilform-attenuate, slightly constricted toward base, 16-22 mm. wide, glabrous above, densely white-lepidote beneath, serrate at base with spines 2 mm. long. Scape furfuraceous or glabrescent. Scape-bracts narrowly triangular, tomentose-lepidote, the upper much shorter than the internodes. Inflorescence laxly racemose, to 4 dm. long, sparsely furfuraceous or glabrous. Floral bracts ovate, attenuate or apiculate, from shorter than the pedicels to slightly exceeding them. Flowers erect to subspreading, fragrant like pineapple. Pedicels 15-25 mm. long. Sepals narrowly subtriangular, obtuse, 20-30 mm. long. Petals to 9 cm. long, red or green with purple lines, bearing a large oblong scale. Stamens included. Ovary 5/6 superior. Seeds long-caudate. BOLIVIA: *Bang s. n.* (NY; type of *P. sessiliflora* Rusby); LA PAZ: NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 3675 (NY, US).

11. **P. Brittoniana** Mez in DC. Monog. Phan. **9:** 451 (1896). Terrestrial or epiphytic, caulescent, flowering 1-1.5 m. high. Leaves over 1 m. long, the sheaths inconspicuous, the petioles 15-40 cm. long, coarsely spinose-serrate, the blades broadly oblanceolate, acute, 95 mm. wide, entire, soon glabrous. Inflorescence simple, 3-6 dm. long, dense, secund-flowered, the axis sparsely and finely brown-lepidote. Floral bracts ovate, acute, much shorter than the sepals, thin and soon disintegrating. Pedicels to 8 mm. long. Sepals lanceolate, attenuate with an involute uncinate apex, more or less asymmetric, 30-35 mm. long, ecarinate, thick, dark red, sparsely tomentose-lepidote toward apex. Petals broadly obtuse, 4 cm. long, orange, bearing 2 narrow obliquely attached scales near the base. Stamens included. Ovary more than ½ superior. Ovules long-caudate. LA PAZ: YUNGAS: *Bang* 592 (US; type; NY); LARECAJA: Tipuani, 1400 m., *Buchtien* 5348 (GH, US).

6. **Dyckia** Schult. f.

Small to large herbs. Rhizome stout, often repent. Leaves densely rosulate, the sheaths ample, rather fleshy, the blades long and narrow, not contracted at base, spinose-serrate, rigid. Scape evident, erect, usually lateral. Inflorescence amply paniculate to simple, its bracts inconspicuous. Flowers relatively small, yellow to red. Sepals free, shorter than the petals. Petals with their bases fused into a tube with the bases of the stamens. Stamens included or exserted, the filaments free or connate above the common tube. Ovary wholly superior. Style distinct to none. Ovules many, alate.

a. Filaments free above the common tube formed by the petals and stamens together.
  b. Stamens exserted; inflorescence glabrous.
    c. Styles distinct; inflorescence simple. ..... 1. *D. leptostachya.*
    c. Styles none; inflorescence compound. ..... 2. *D. pulquinensis.*

b. Stamens included; inflorescence cinereous-tomentose. .... 3. *D. ferox.*

a. Filaments connate above the common tube formed by the petals and stamens together; inflorescence simple, minutely furfuraceous; styles distinct. ..... 4. *D. gracilis.*

1. **Dyckia leptostachya** Baker in Gard. Chron. **1884**(2): 198 (1884). *D. boliviensis* Mez in DC. Monog. Phan. **9:** 524 (1896). Leaves unknown. Scape slender, glabrous. Scape-bracts remote, small, very broadly ovate. Inflorescence simple, 15 cm. long, subdense, glabrous. Floral bracts reflexed, suborbicular, 4 mm. long, much exceeded by the sepals. Flowers subsessile, erect, 17 mm. long, red. Sepals broadly elliptic, emarginate, 9 mm. long. Petal-blades erect, very broadly obovate, subtruncate, obscurely if at all carinate. Stamens barely exserted, free above the common tube with the petals. Style half as long as the ovary. SANTA CRUZ: CHIQUITOS: Santiago, *d'Orbigny* 858 (P; type of *D. boliviensis* Mez).

2. **D. pulquinensis** Wittm. in Meded. Rijks Herbar. **29:** 88 (1916). Leaves 14 cm. long, the blades 6 mm. wide, very laxly serrate with stout retrorse spines 5 mm. long. Scape very slender. Scape-bracts remote, triangular-ovate, acute, the upper ones 8 mm. long. Inflorescence few-branched. Primary bracts like the upper scape-bracts, much shorter than the sterile bracteate bases of the branches. Branches flexuous, very slender, laxly and subsecundly flowered. Floral bracts broadly ovate, apiculate, 3 mm. long. Flowers subsessile, 15 mm. long, glabrous. Sepals broadly ovate-elliptic, apiculate, 8 mm. long, fuscous when dry. Petals broadly obovate, rounded at apex, 14 mm. long, golden yellow, forming a tube with the stamens 1.5 mm. high. Stamens slightly exserted, free above the common tube. Ovary slenderly ellipsoid, 9 mm. long, the stigmas sessile. SANTA CRUZ: VALLE GRANDE: Pulquina, *Herzog* 1849 (L; type); *Cárdenas* 6075 (US); San Isidro, Comarapa, *Vogel* 477 (US).

3. **D. ferox** Mez in DC. Monog. Phan. **9:** 511 (1896). *D. Meziana* O. Kuntze of Catalogue. Flowering 6 dm. high. Leaf-blades 8-20 mm. wide, covered beneath with pale closely appressed scales, laxly serrate with acicular antrorse spines 4-6 mm. long. Scape slender, soon glabrous. Scape-bracts remote, very broadly ovate, abruptly acute, entire. Inflorescence simple or few-branched, cinereous-tomentose to glabrous. Primary bracts scarcely larger than the floral bracts. Floral bracts spreading or reflexed, suborbicular-ovate, obtuse or apiculate, much shorter than the sepals. Flowers subsessile. Sepals broadly elliptic, broadly rounded, ca. 5 mm. long, subglabrous. Petals to 12 mm. long, the blades suberect, subrhombic, scarcely undulate, ecarinate or nearly so. Stamens included, the filaments free above the common tube with the petals. Styles 3, very short. SANTA CRUZ:

CORDILLERA: Cerro de Charagua, 1200 m., *Cárdenas* 2679 (GH). Paraguay, Argentina.

4. **D. gracilis** Mez in DC. Monog. Phan. **9:** 516 (1896). Flowering 5 dm. high. Leaf-blades 3 dm. long, 20-25 mm. wide, covered beneath with closely appressed pale cinereous scales, serrate with spines 4 mm. long. Scape very slender, glabrous. Scape-bracts remote, broadly ovate with a short acuminate apex, entire. Inflorescence simple, lax, minutely furfuraceous. Floral bracts reflexed, suborbicular, apiculate, ca. 4 mm. long. Flowers suberect, subsessile, slender. Sepals broadly elliptic, emarginate, 7-9 mm. long. Petals 14-18 mm. long, equaling or slightly shorter than the stamens, the blade erect, obovate, nearly or quite ecarinate. Stamens connate above the common tube with the petals. Style 2-3 times shorter than the ovary. SANTA CRUZ: CHIQUITOS: San Rafael, *d'Orbigny* 1006 (P; type); ORIENTE: Roboré, 230 m., *Cárdenas* 2917 (GH); VELASCO: San Ignacio, *I. S. Nelson* s. n. (US); *Cárdenas* 5624 (US).

Key to the species of **Tillandsioideae** in fruiting condition (The numbers refer to the species in the respective genera).

a. Spikes with the flowers distichous (sometimes becoming secund) or else the inflorescence reduced to a single flower.
  b. Sepals asymmetric, free, oblong or broadest near the apex, not over 9.5 mm. long ..... *Tillandsia* subgenus *Pseudo-Catopsis.*
  b. Sepals symmetric or, if slightly asymmetric, then ovate or lanceolate and broadest near the base.
    c. Leaf-blades ligulate or lanceolate with curving sides, mostly flat, thin, and obscurely lepidote ..... Subkey I.
    c. Leaf-blades very narrowly triangular or linear, frequently involute or densely and coarsely lepidote or both.
      d. Inflorescence compound ..... Subkey II.
      d. Inflorescence simple ..... Subkey III.
a. Spikes with the flowers in more than 2 ranks ..... Subkey IV.

Subkey I

a. Inflorescence compound.
  b. Primary bracts much shorter than the branches.
    c. Flowers suberect, imbricate ..... *Tillandsia* 1-7.
    c. Flowers spreading, very lax ..... *Tillandsia* 28.
  b. Primary bracts covering most or all of each lower spike .... *Tillandsia* 12, 13.
a. Inflorescence simple.
  d. Flowers imbricate.
    e. Inflorescences many, axillary ..... *Tillandsia* 18.
    e. Inflorescence single, central.
      f. Floral bracts ecarinate, inflated, the keel curved .... *Tillandsia* 17.

f. Floral bracts carinate, laterally compressed, the keel sigmoid in outline ..... *Vriesea* 3.
d. Flowers divergent, lax ..... *Vriesea* 4.

Subkey II

a. Primary bracts much shorter than the branches or spikes.
b. Leaves spirally recurved and holding the plant to a branch ..... *Tillandsia* 29.
b. Leaves not more than recurved, not spiral.
c. Inflorescence amply tripinnate, elongate; sepals 10-13 mm. long ..... *Tillandsia* 8, 9.
c. Inflorescence bipinnate or rarely a basal branch divided.
d. Leaf-sheaths large, castaneous, strongly contrasting with the blades; floral bracts ecarinate.
e. Floral bracts 25-35 mm. long ..... *Vriesea* 1.
e. Floral bracts 7-13 mm. long.
f. Inflorescence subdigitate; spikes 9-16 cm. long ..... *Tillandsia* 10.
f. Inflorescence elongate; spikes 4-7 cm. long above the sterile base ..... *Vriesea* 2.
d. Leaf-sheaths not contrasting greatly with the blades.
g. Floral bracts distinctly shorter than the 10-13 mm. long sepals; plants somewhat caulescent; leaf-blades covered with more or less spreading cinereous scales ..... *Tillandsia* 29, 30.
g. Floral bracts mostly equaling to much exceeding the sepals.
h. Scales of the leaf-blades very closely appressed.
i. Floral bracts 10 mm. long, even, glabrous; leaf-blades thick ..... *Tillandsia* 25.
i. Floral bracts 15-24 mm. long .... *Tillandsia* 53-55.
h. Scales of the leaf-blades more or less spreading.
j. Floral bracts 30 mm. long, cinereous-lepidote .... *Tillandsia* 11.
j. Floral bracts 11-25 mm. long, mostly glabrous ..... *Tillandsia* 22, 24.
a. Primary bracts covering most or all of each lower spike.
k. Leaf-blades linear-subulate ..... *Tillandsia* 52.
k. Leaf-blades narrowly but definitely triangular .. *Tillandsia* 14-16.

Subkey III

a. Plants stemless; scales of the leaf-blades very closely appressed; leaf-sheaths conspicuous.
b. Leaf-sheaths dark castaneous, contrasting with the blades ..... *Vriesea* 1.
b. Leaf-sheaths little if at all darker than the blades. ..... *Tillandsia* 52-54.

a. Plants caulescent; scales of the leaf-blades usually somewhat spreading; leaf-sheaths inconspicuous.
c. Leaves in more than 2 ranks.
d. Scape wholly covered by its bracts.
e. Flowers imbricate.
f. Floral bracts equaling or exceeding the sepals; sepals 15-20 mm. long.
g. Floral bracts all densely and persistently lepidote ..... (*Tillandsia* 11.)
g. Floral bracts glabrous or nearly so.
h. Leaves strict, covered with appressed inconspicuous scales ..... *Tillandsia* 23.
h. Leaves lax or contorted, covered with more or less spreading conspicuous scales.
i. Floral bracts to 7 cm. long, much exceeding the sepals ..... *Tillandsia* 21.
i. Floral bracts 10-27 mm. long.
j. Floral bracts much exceeding the sepals, wholly covering the rhachis, 27 mm. long ..... *Tillandsia* 19.
j. Floral bracts equaling or barely exceeding the sepals, exposing much of the rhachis, 10-25 mm. long.
k. Plant long-caulescent, the leaves mostly shorter than the stem, the blades 4-6 mm. wide ..... *Tillandsia* 32.
k. Plant short-caulescent, the leaves much longer than the stem, the blades to 20 mm. wide ..... *Tillandsia* 22.
f. Floral bracts distinctly shorter than the sepals; sepals 6.5-17 mm. long.
l. Plant moss-like; sepals 6.5 mm. long ..... *Tillandsia* 36.
l. Plant not moss-like; sepals 10-17 mm. long ..... *Tillandsia* 29-32.
e. Flowers lax, appressed to the geniculate rhachis ..... *Tillandsia* 35.
d. Scape exposed for most of its length or else wanting; scape-bracts not more than 2 ..... *Tillandsia* 37, 38.
c. Leaves in exactly 2 ranks.
m. Stem wholly concealed by the imbricate leaf-sheaths, short; scape more or less developed.
n. Sepals free or equally short-connate; 1-2 scape-bracts often present.
o. Leaf-blades narrowly triangular, mucronate, usually well over 2 mm. in diameter.

p. Leaves tomentose-lepidote ..... *Tillandsia* 33.
p. Leaves appressed- or slightly pruinose-lepidote .... *Tillandsia* 38-40.
o. Leaf-blades linear with a soft blunt apex, not over 2 mm. in diameter.
q. Floral bracts glabrous ..... *Tillandsia* 34.
q. Floral bracts densely lepidote ..... *Tillandsia* 41.
n. Sepals much connate posteriorly; scape naked. .... *Tillandsia* 42.
m. Stem exposed between alternating bunches of leaves, several meters in length ..... *Tillandsia* 43.

Subkey IV

a. Inflorescence compound, the spikes lax or sublax and showing the rhachis ..... *Guzmania* 1.
a. Inflorescence simple, dense with the rhachis completely covered.
b. Leaf-blades ligulate.
c. Inflorescence much longer than broad, acute .. *Guzmania* 3, 4.
c. Inflorescence about as broad as long.
d. Outer bracts of the inflorescence forming an involucre .... *Guzmania* 2.
d. Outer bracts of the inflorescence not forming an involucre.
e. Leaf-blades broadly rounded and retuse .. *Guzmania* 5.
e. Leaf-blades acute ..... *Tillandsia* 13.
b. Leaf-blades narrowly triangular or linear-subulate.
f. Leaf-blades linear-subulate; floral bracts coriaceous or subcoriaceous, densely lepidote ..... *Tillandsia* 52.
f. Leaf-blades narrowly but definitely triangular; floral bracts thin.
g. Sepals glabrous.
h. Sepals ovate, 19 mm. long ..... *Tillandsia* 20.
h. Sepals lanceolate, 10 mm. long ..... *Tillandsia* 26.
g. Sepals lepidote, thick, coriaceous ..... *Tillandsia* 27.

7. Tillandsia L.

Caulescent or acaulescent herbs of very variable habit. Leaves rosulate or fasciculate or distributed along a stem, polystichous or distichous, entire, ligulate or narrowly triangular or linear. Scape usually distinct. Inflorescence various, usually of distichous-flowered spikes or sometimes reduced to a single polystichous-flowered spike by the reduction of the spikes to single flowers or rarely the whole inflorescence reduced to a single flower. Sepals usually symmetric, free, or equally or posteriorly joined. Petals free, naked. Stamens of various lengths relative to the petals and pistil. Ovary superior, glabrous. Ovules usually many, caudate. Capsule septicidal. Seeds erect, narrowly cylindric or fusiform, the plumose appendage white, straight, basal.

a. Stamens equaling the petals or shorter.
b. Sepals symmetric, or if slightly asymmetric then ovate or lanceolate and broadest below the middle.
c. Stamens appearing in the throat of the corolla; style slender, much longer than the ovary.
d. Filaments straight; flowers almost always distichous.
e. Stamens only a little shorter than the narrow suberect entire petal-blades ..... 1. Subgenus *Allardtia.*
e. Stamens barely exceeding the claws of the petals; petal-blades spreading, broad, crenate-serrate; inflorescence simple ..... 2. Subgenus *Aërobia.*
d. Filaments more or less transversely plicate; flowers often polystichous in a simple inflorescence. .... 3. Subgenus *Anoplophytum.*
c. Stamens deeply included; style short and stout.
f. Petal-blades broad, conspicuous; inflorescence compound or simple ..... 4. Subgenus *Phytarrhiza.*
f. Petal-blades narrow, inconspicuous; inflorescence simple. ..... 5. Subgenus *Diaphoranthema.*
b. Sepals asymmetric, nearly or quite free, broadest near the apex, not over 9.5 mm. long ..... 6. Subgenus *Pseudo-Catopsis.*
a. Stamens longer than the petals, exserted .... 7. Subgenus *Tillandsia.*

1. Subgenus *Allardtia*

a. Flowers distichous; inflorescence compound or simple.
b. Inflorescence compound.
c. Spikes much exceeding the primary bracts.
d. Leaf-blades ligulate, the sides not evenly attenuate.
e. Sepals equally free or subfree.
f. Floral bracts ample and wholly concealing the rhachis; posterior sepals carinate, 25-45 mm. long. .... 1. *T. Fendleri.*
f. Floral bracts narrow and exposing much of the rhachis.
g. Sepals 22-40 mm. long; inflorescence amply tripinnate. ..... 2. *T. maxima.*
g. Sepals 12-15 mm. long; inflorescence bipinnate or the lowest branches sometimes divided. ..... 3. *T. rubella.*
e. Sepals connate posteriorly more than elsewhere.
h. Inflorescence amply tripinnate; sepals 14-19 mm. long.
i. Spikes fascicled, linear, many-flowered. .... 4. *T. boliviana.*
i. Spikes pinnate along 35 cm. long branches, narrowly lanceolate, 5-7 flowered. ..... 5. *T. Krukoffiana.*
h. Inflorescence bipinnate; sepals 15-26 mm. long.
j. Leaves densely lepidote on both sides; sepals 26 mm. long. ..... 6. *T. Kuntzeana.*

j. Leaves glabrous above; sepals 15 mm. long. ..... 7. *T. confinis.*

d. Leaf-blades narrowly triangular with straight evenly attenuate sides.

k. Inflorescence amply tripinnate, elongate; sepals 10-13 mm. long.

l. Spikes dense; floral bracts exceeding the sepals. ..... 8. *T. longifolia.*

l. Spikes very lax; floral bracts shorter than the sepals. .... 9. *T. marantoidea.*

k. Inflorescence not more than bipinnate; sepals 8-21 mm. long.

m. Sepals obtuse, 8 mm. long; inflorescence of several spikes. ..... 10. *T. Rusbyi.*

m. Sepals acute, 21 mm. long; inflorescence of 2 spikes. .... 11. *T. boliviensis.*

c. Spikes slightly *(T. calocephala)* if at all exceeding the lower primary bracts.

n. Leaf-blades ligulate, the sides not evenly attenuate.

o. Inflorescence tripinnate; sepals ecarinate. .... 3. *T. rubella.*

o. Inflorescence bipinnate.

p. Spikes 1-4-flowered; leaf-sheaths green or purplish.

q. Sepals about equaling the floral bracts, even; leaf-blades 4-6 cm. wide. ..... 12. *T. violascens.*

q. Sepals exceeding the floral bracts, nerved; leaf-blades 2 cm. wide. ..... 13. *T. biflora.*

p. Spikes 6-7-flowered; leaf-sheaths very dark castaneous, nearly black. ..... 14. *T. fusco-guttata.*

n. Leaf-blades narrowly triangular, the sides evenly attenuate; spikes to 3-flowered; sepals acute.

r. Plant stemless; leaves 20-40 cm. long; inflorescence 5-6 cm. long. ..... 15. *T. sphaerocephala.*

r. Plant caulescent; leaves 6-10 cm. long; inflorescence 25 mm. long. ..... 16. *T. calocephala.*

b. Inflorescence simple.

s. Leaf-blades ligulate.

t. Scape central, solitary; spike 20 cm. long, 40 mm. wide. .... 17. *T. Walteri.*

t. Scapes axillary, numerous; spike to 8 cm. long, 15-20 mm. wide. ..... 18. *T. complanata.*

s. Leaf-blades narrowly-triangular.

u. Floral bracts all densely and persistently lepidote. .... (11. *T. boliviensis* probably has a simple inflorescence).

u. Floral bracts glabrous or nearly so. ..... 19. *T. Cardenasii.*

a. Flowers polystichous; inflorescence simple.

v. Leaf-blades ligulate; petals blue, lavender, or purple. ..... 13. *T. biflora.*
v. Leaf-blades narrowly triangular; petals yellow. .... 20. *T. ixioides.*

2. Subgenus *Aërobia*

A single species. ..... 21. *T. xiphioides.*

3. Subgenus *Anoplophytum*

a. Flowers distichous; inflorescence usually compound.
b. Leaves covered with conspicuous spreading scales especially along the margins; floral bracts 20-25 mm. long, nearly or quite glabrous, ecarinate. ..... 22. *T. Lorentziana.*
b. Leaves covered with appressed or subappressed scales; floral bracts 10-20 mm. long.
c. Plant caulescent; inflorescence simple. ..... 23. *T. caulescens.*
c. Plant stemless; inflorescence usually compound.
d. Floral bracts strongly nerved, usually cinereous-lepidote, carinate. ..... 24. *T. didisticha.*
d. Floral bracts nearly or quite even, lepidote at apex, ecarinate. ..... 25. *T. vernicosa.*
a. Flowers polystichous; inflorescence simple.
e. Sepals membranaceous, much longer than broad, glabrous. ..... 26. *T. tenuifolia.*
e. Sepals coriaceous, suborbicular, lepidote. ..... 27. *T. Pohliana.*

4. Subgenus *Phytarrhiza*

a. Leaf-blades ligulate, flat; spikes very lax. ..... 28. *T. laxissima.*
a. Leaf-blades very narrowly triangular, mostly involute; spikes dense.
b. Scape-bracts imbricate or nearly so, covering most or all of the scape; leaves polystichous.
c. Leaves strongly coiled, stout; inflorescence long, often tripinnate. ..... 29. *T. Duratii.*
c. Leaves merely curved, slender; inflorescence not more than bipinnate, digitate or simple.
d. Leaf-blades covered with subappressed scales; plant caulescent. ..... 30. *T. Reichenbachii.*
d. Leaf-blades covered with narrow spreading scales.
e. Leaves longer than the stem; inflorescence usually compound. ..... 31. *T. streptocarpa.*
e. Leaves shorter than the elongate stem; inflorescence simple. ..... 32. *T. paleacea.*
b. Scape-bracts remote, leaving most of the setiform scape exposed; leaves distichous.
f. Floral bracts densely tomentose-lepidote, about equaling the sepals; leaf-blades 2-5 mm. in diameter; petals yellow. ..... 33. *T. crocata.*

f. Floral bracts glabrous or nearly so, mostly shorter than the sepals; leaf-blades 1-2 mm. in diameter; petals blue or violet. ..... 34. *T. bandensis.*

5. Subgenus *Diaphoranthema*

a. Scape-bracts numerous, about equaling the internodes; leaves polystichous.
b. Spike lax, linear, the flowers less than twice as long as the internodes. ..... 35. *T. loliacea.*
b. Spike dense or 1-flowered, lanceolate, the flowers more than twice as long as the internodes. ..... 36. *T. tricholepis.*

a. Scape-bracts not more than 2, the scape when present largely naked.
c. Leaves 4-9 mm. long, polystichous, the plant resembling a coarse moss. ..... 37. *T. bryoides.*
c. Leaves much larger, distichous (sometimes polystichous in *T. funebris*).
d. Stem wholly concealed by the imbricate leaf-sheaths, short; scape more or less developed.
e. Sepals free or equally short-connate; 1-2 scape-bracts often present.
f. Leaf-blades narrowly triangular, mucronate, usually well over 2 mm. in diameter.
g. Floral bracts glabrous. ..... 38. *T. funebris.*
g. Floral bracts densely lepidote.
h. Leaf-blades laterally compressed; leaf-sheaths indistinct, but a little broader than the blades, enfolding the stem only by their extreme base. .... 39. *T. Gilliesii.*
h. Leaf-blades terete; leaf-sheaths distinct, much broader than the blades, enfolding the stem for most of their length. ..... 40. *T. myosura.*
f. Leaf-blades linear with a soft blunt apex, not over 2 mm. in diameter; inflorescence dense or 1-flowered. ..... 41. *T. recurvata.*
e. Sepals much connate posteriorly; scape naked. ..... 42. *T. capillaris.*
d. Stem exposed between alternating bunches of leaves, several meters in length. ..... 43. *T. usneoides.*

6. Subgenus *Pseudo-Catopsis*

a. Inflorescence simple or few-branched; floral bracts suborbicular, exceeding the flowers, membranaceous. ..... 44. *T. Seemannii.*
a. Inflorescence much branched.
b. Floral bracts about equaling the sepals or distinctly longer.
c. Floral bracts even or faintly few-nerved near the margin, without a midnerve.
d. Floral bracts not incurved, almost exactly equaling the sepals; spikes to 9 cm. long. ..... 45. *T. spiculosa.*

d. Floral bracts incurved toward apex, definitely exceeding the sepals; spikes 4 cm. long. ..... 46. *T. monticola.*
c. Floral bracts sulcate and with a definite midnerve, exceeding the sepals. ..... 47. *T. pendulispica.*
b. Floral bracts distinctly shorter than the sepals.
e. Inflorescence tripinnate.
f. Leaf-blades broadly ligulate; inflorescence sparsely whitish-lepidote. ..... 48. *T. pardina.*
f. Leaf-blades narrowly triangular; inflorescence ferruginous-lepidote. ..... 49. *T. Bakeri.*
e. Inflorescence bipinnate; leaf-blades narrowly triangular.
g. Scape-bracts remote; primary bracts many times shorter than the branches. ..... 50. *T. parviflora.*
g. Scape-bracts mostly equaling or exceeding the internodes; primary bracts at least half as long as the branches. ..... 51. *T. adpressa.*

7. Subgenus *Tillandsia*

a. Leaf-sheaths nearly flat, not forming a pseudobulb.
b. Leaf-blades linear-subulate; inflorescence digitate or simple and with polystichous flowers. ..... 52. *T. juncea.*
b. Leaf-blades narrowly but definitely triangular.
c. Floral bracts coriaceous; about equaling the sepals. ..... 53. *T. polystachia.*
c. Floral bracts submembranaceous, much exceeding the sepals. ..... 54. *T. Valenzuelana.*
a. Leaf-sheaths inflated and forming a pseudobulb; scape-bracts vaginiform; sepals ecarinate. ..... 55. *T. paraënsis.*

1. **Tillandsia Fendleri** Griseb. in Goett. Nachr. **1864:** 17. 1865. *T. Bangii* Baker in Mem. Torr. Bot. Club **6:** 124 (1896). *T. Deppiana* var. *latifolia* (Griseb.) L. B. Smith of Catalogue. Stemless, to 2 m. high. Leaves 6-10 dm. long, the blades ligulate, triangular-attenuate, to 8 cm. wide, flat, nearly or quite glabrous. Scape erect, stout. Scape-bracts densely imbricate, foliaceous. Inflorescence mostly bipinnate. Primary bracts like the upper scape-bracts, much shorter than the branches but much larger than the floral bracts. Spikes acute, complanate, densely 6-many-flowered, mostly spreading, 10-30 cm. long, 5 cm. wide, mostly short-stipitate. Floral bracts obovate, carinate toward apex, ample and concealing the rhachis, coriaceous, rigid, glabrous, even, about equaling the sepals. Flowers short-stipitate. Sepals oblong-lanceolate, 25-45 mm. long, carinate, equally subfree. Petals slightly exceeding the stamens, blue. LA PAZ: SUR YUNGAS: Asunta, near Evenay, 690-750 m., *Krukoff* 10568 (GH, NY, US). COCHABAMBA: CERCADO: Cochabamba, *Bang*, 1283 (G, GH, US; type-number of *T. Bangii* Baker); CHAPARE: Antahuacana, Espíritu Santo, 750 m., *Buchtien* s. n., 2224 (US). West Indies to Venezuela and Bolivia.

2. **T. maxima** Lillo & Hauman in Anal. Mus. Nac. Buenos Aires, **29:** 416 (1917). *T. australis* Mez of Catalogue. *T. maxima* var. *densior* L. B. Smith in Lilloa, **14:** 97 (1948). Flowering 8-24 dm. high with the inflorescence extended. Leaves many in a spreading rosette, the blades ligulate, subrounded, apiculate, 6-12 cm. wide, subglabrous. Scape very stout, erect and then decurved. Scape-bracts densely imbricate, foliaceous. Inflorescence amply tripinnate, very variable, glabrous. Primary bracts like the scape-bracts, ligulate, mostly much shorter than the branches. Branches bearing 1-7 spikes, the rather large sterile base bracteate. Secondary bracts much reduced, ovate, acute. Spikes lanceolate to linear, 11-30 cm. long, sublax to subdense. Floral bracts suberect, narrow and exposing most of the rhachis, broadly elliptic, equaling or slightly exceeding the sepals, even (! Castellanos) and apparently fleshy, becoming coarsely rugose when dry, ecarinate, not incurved. Sepals free, subobtuse, 22-40 mm. long, ecarinate toward apex. Petals blue or violet. Stamens included. LA PAZ: LARECAJA: Sorata, Cerro de S. Iminapi, 2650 m., *Mandon* 1187 e. p. (BM). COCHABAMBA: AYOPAYA: Sailapata, 2500 m., *Cárdenas* 3387 (GH); CAMPERO: Río Caine, 2800 m., *Cárdenas* 2113 (GH, US; type number of *T. maxima* var. *densior* L. B. Smith); MIZQUE [?]: Sevingania to Vilavila, 3900 m., *M. B. Foster* 2554 (US); TOTORA [?]: Km. 450, Cochabamba to Santa Cruz, 1200 m., *Cárdenas* 5207 (US). TARIJA: ARCE: La Merced, Bermejo, 1700 m., *Fiebrig* 2161 (GH, US). Argentina.

3. **T. rubella** Baker in Journ. Bot. **26:** 44 (1888). Stemless, propagating by stolons 9-15 dm. long, flowering 5-13 dm. high. Leaves 3-6 dm. long, the blades ligulate, acute with a recurved apex, 3-5 cm. wide, subglabrous, sometimes with fine purple spots. Scape 9-14 mm. in diameter, glabrous. Scape-bracts densely imbricate, lance-elliptic, acute. Inflorescence 2-3-pinnate, ellipsoid to subthyrsoid, dense toward apex, interrupted below, glabrous or nearly so, red. Primary bracts spreading, ovate, the lowest attenuate and exceeding the branches, the upper acute, shorter than the branches. Branches short with spikes solitary or fasciculate. Secondary bracts scarcely larger than the floral bracts. Spikes lanceolate, acute, 4-6 cm. long, 16-20 mm. wide, slightly complanate, subdensely 8-12-flowered. Floral bracts imbricate but partially exposing the rhachis, broadly ovate, subobtuse, 14-20 mm. long, slightly exceeding the sepals, submembranaceous, strongly nerved. Sepals ovate, subacute, 12-15 mm. long, equally subfree, ecarinate. Petals erect, 23 mm. long, the blades narrowly elliptic. Stamens included. LA PAZ: LARECAJA: Sorata, 2650 m., *Mandon* 1187 (GH; type-number); COCHABAMBA: CERCADO: Tunari, 2400 m., *Foster* 2533 (US).

According to M. B. Foster, the young shoots of this species and of *T. maxima* are edible and are sold in the markets under the name "Horka".

4. **T. boliviana** Mez in Bull. Herb. Boiss. (ser. 2) **4:** 1130 (1904). Plant large, known only from fragments. Leaves in a funnelform rosette, 4 dm. long, the blades ligulate, subacute and apiculate, 35 mm. wide, densely appressed-lepidote on both sides. Scape unknown. Inflorescence amply tripinnate, glabrous. Branches with 6 spikes, at base 2 sterile bracts, the axis compressed. Secondary bracts inconspicuous. Spikes subsessile, nutant, linear, acute, 17 cm. long, 12 mm. wide, strongly complanate, to 32-flowered. Rhachis geniculate, angled. Floral bracts ovate-elliptic, obtuse, 17 mm. long, slightly exceeding the sepals, about 3 times as long as the internodes but not covering the rhachis, coriaceous, strongly nerved, obscurely carinate toward apex. Flowers subsessile, 22 mm. long. Sepals elliptic, obtuse, 14 mm. long, chartaceous, prominently nerved, connate for 6 mm. posteriorly and 2 mm. anteriorly. Petals violet, the blades suberect, elliptic. Stamens included. WITHOUT DEPARTMENT: *Bang* 2202 (GH, type-number).

5. **T. Krukoffiana** L. B. Smith in Contrib. Gray Herb. **154:** 36 (1945). Flowering at least 2 m. high. Leaves to 8 dm. long, the blades ligulate, acute or attenuate, 6 cm. wide, glabrous. Scape unknown. Inflorescence ample, very laxly 3-pinnate, the axes slender, glabrous. Primary bracts ovate, acute, 4 cm. long, shorter than the long sterile bases of the branches. Branches spreading, to 35 cm. long, bearing 1-5 sterile bracts at base. Secondary bracts like the primary but much smaller, half as long as the spikes. Spikes spreading or deflexed, narrowly lanceolate, acute, 45-65 mm. long, 10-15, mm. wide, complanate, subdensely 5-7-flowered. Floral bracts elliptic, acute, to 25 mm. long, carinate toward apex, subchartaceous, nerved, sparsely and obscurely lepidote. Flowers subsessile. Sepals elliptic, 19 mm. long, nerved, glabrous, the posterior carinate, connate for 4 mm. LA PAZ: SUR YUNGAS: Río Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10503 (GH; type).

6. **T. Kuntzeana** Mez in DC. Monog. Phan. **9:** 790 (1896). Stemless, flowering to over 1 m. high. Leaves many, the blades attenuate, 30 mm. wide, covered on both sides with pale appressed scales. Scape erect, stout, glabrous. Scape-bracts imbricate, elliptic, acute or attenuate, coriaceous, lepidote. Inflorescence pinnate from 4-5 spikes, 2 dm. long. Primary bracts like the upper scape-bracts, much shorter than the spikes. Spikes erect, sessile, 10 cm. long, slightly complanate,

densely 8-flowered. Floral bracts elliptic, acute, mucronate, 32 mm. long, 17 mm. wide, exceeding the sepals, sharply carinate, incurved at apex, coriaceous, even, glabrous. Flowers subsessile. Sepals linear, subacute, 26 mm. long, submembranaceous, nerved, glabrous, the posterior 1/3 connate. COCHABAMBA: CERCADO: Tunari, *Kuntze* (NY; type).

7. **T. confinis** L. B. Smith, Phytologia, **4**: 218, t. 2, figs. 5-7 (1953). *T. subtropicalis* L. B. Smith in Phytologia, **8**: 505 (1963). Stemless, flowering 3 dm. high. Leaves 20-23 cm. long, the blades ligulate with a long attenuate apex, 15-20 mm. wide, covered beneath with fine appressed cinereous scales, glabrous above. Scape erect, slender. Scape-bracts densely imbricate, the lowest subfoliaceous, the others elliptic, glabrous and lustrous except for the small narrow blade. Inflorescence laxly bipinnate from 5-7 spikes, glabrous. Primary bracts ovate, about half as long as the spikes. Spikes subspreading, subsessile, lanceolate, acute, 45 mm. long, 12 mm. wide, strongly complanate, dense. Floral bracts wholly concealing the rhachis, ovate, acute, 18 mm. long, sharply carinate with a straight apex, coriaceous, even, lustrous. Sepals lanceolate, acute, 15 mm. long, the posterior carinate, 2/3 connate. LA PAZ: LARECAJA: Hacienda Casana, Tipuani, 1400 m., *Buchtien* 7185 (US; type of *T. subtropicalis* L. B. Smith); same, 7187. Venezuela, Colombia, Ecuador, Peru.

8. **T. longifolia** Baker, Handbk. Bromel. 185 (1889). Flowering 2-3 m. high. Leaves 8-10 dm. long, the blades very narrowly triangular, 3-4 cm. wide, subdensely appressed-lepidote on both sides. Scape erect, very stout. Scape-bracts imbricate, foliaceous. Inflorescence pyramidal, tripinnate. Primary bracts ovate, the lowest with long foliaceous blades exceeding the branches. Branches suberect, to 2 dm. long, the sterile bases laxly bracteate. Spikes short-stipitate, linear-lanceolate, acute, 4-12 cm. long, complanate, densely 4-12-flowered. Floral bracts ovate, obtuse, to 15 mm. long, broadly convex with a thickened midnerve but scarcely carinate, coriaceous, nerved, glabrous. Sepals obovate, obtuse, 10-12 mm. long, short-connate posteriorly. Stamens included. SANTA CRUZ: CERCADO: Yungas de San Mateo, Comarapa, 2800 m., *Steinbach* 8467 (GH). Colombia, Venezuela.

9. **T. marantoidea** Rusby, Descr. S. Amer. Pls. 4 (1920). Caulescent, flowering over 1 m. high with an erect stem 15-20 cm. long. Leaves to 6 dm. long, the blades linear, attenuate, 10-12 mm. wide, very obscurely lepidote beneath. Scape-bracts erect, 6-15 cm. long, attenuate. Inflorescence laxly tripinnate, 45 cm. long, glabrous. Primary bracts ovate, acute, 3 cm. long, much exceeding the short naked sterile bases of the branches, subchartaceous, red. Branches spreading, subdigitately divided, the median to 10 cm. long, the lower shorter and more remote. Secondary bracts like the floral bracts. Spikes 5-8 cm. long, very lax with the flowers subspreading and about 1 cm. apart. Rhachis nearly straight, very slender, angled. Floral bracts elliptic, obtuse, 13-15 mm. long, exceeded by the sepals, ecarinate, thin, nerved. Pedicels stout. Sepals lanceolate, obtuse, 13 mm. long, ecarinate, nerved. Petal-blades 7 mm. long. Stamens included. WITHOUT DEPARTMENT: *Bang* 2570 (NY; type; US).

10. **T. Rusbyi** Baker, Handbk. Bromel. 176 (1889). *T. Buchtienii* H. Winkl. in Fedde, Repert. Spec. Nov. **7:** 107 (1909). *T. Guentheri* Harms in Notizbl. **10:** 794 (1929). Leaves about 30 in a dense rosette, exceeding the inflorescence, the sheaths very large, covered with castaneous scales, the blades very narrowly triangular, 10 mm. wide, involute-subulate, covered with cinereous scales. Scape suberect, slender, half as long as the leaves. Scape-bracts densely imbricate, long-laminate. Inflorescence bipinnate, distichous-branched, 11 cm. long and wide, of about 14 spikes. Primary bracts erect, broadly ovate, attenuate, scarcely exceeding the sterile bracteate bases of the branches, lepidote. Spikes suberect to spreading, nearly uniform, linear-lanceolate, acute, 9-16 cm. long, 6 mm. wide, complanate, about 20-flowered. Floral bracts laxly imbricate, subacute, 11-12 mm. long, exceeding the sepals, ecarinate, subchartaceous, nerved, lepidote. Flowers subsessile. Sepals narrowly elliptic, obtuse, 8 mm. long, equally subfree, subcoriaceous, glabrous. Petals white. Stamens included. LA PAZ: Yungas, 1800 m., *Rusby* 2163 (NY; type); LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 369 (B; type of *T. Guentheri* Harms); Hacienda Casana, Tipuani, 1400 m., *Buchtien* 7180 (NY); MURILLO: La Paz, *Buchtien* 1268 (US; type-number of *T. Buchtienii* H. Winkl.); OMASUYOS: Copacabana, Mapiri, 850-950 m., *Krukoff* 11181 (NY). WITHOUT LOCALITY: *Bang* (NY). Peru.

11. **T. boliviensis** Baker in Mem. Torr. Bot. Club, 4 (3): 267 (1895), emend. L. B. Smith in Contrib. Gray Herb. **98:** 15 (1932). Flowering 2 dm. high. Leaves fasciculate-rosulate, about equaling the inflorescence, the blades narrowly triangular, subulate-attenuate, covered with slightly spreading cinereous scales, coarsely fimbriate-lepidote along the margins. Scape almost hidden by the leaves. Scape-bracts imbricate, lanceolate, apiculate or short-caudate, densely cinereous-lepidote. Inflorescence of a terminal spike 8 cm. long and a lateral 4-5 cm. long. Primary bract like the scape-bracts, half as long as the spike. Spikes oblong-lanceolate, 4-10-flowered. Floral bracts imbricate but exposing the rhachis, lanceolate, acute, 30 mm. long, ecarinate, cinereous-lepidote. Flowers subsessile. Sepals narrowly lanceolate, acute, 21 mm. long, free, glabrous, nerved, the posterior alate-carinate. LA PAZ: MURILLO: La Paz, 3300 m., *Bang* 159a in part (NY; type).

12. **T. violascens** Mez in DC. Monog. Phan. **9:** 797 (1896). Caulescent, flowering 4-7 dm. high. Stem decumbent, stout, covered with the remains of old leaves. Leaves 3-5 dm. long, the sheaths distinct, elliptic, to 18 cm. long, dark violet, the blades ligulate, attenuate, 4-6 cm. wide, minutely and obscurely punctulate-lepidote. Scape erect, to 14 mm. in diameter, glabrous. Scape-bracts densely imbricate, foliaceous with subinflated sheaths. Inflorescence densely bipinnate, thyrsoid, 15-25 cm. long, 10 cm. in diameter, red or green. Primary bracts suberect, the middle and lower subfoliaceous and exceeding

the spikes, the upper suborbicular, apiculate, about equaling the spikes. Spikes sessile or with a short naked stipe, elliptic, subdensely 4-flowered, 4 cm. long. Floral bracts broadly ovate, rounded, about equaling the sepals, carinate, even, glabrous. Sepals elliptic, broadly rounded, 8-15 mm. long, chartaceous, even, glabrous. LA PAZ: LARECAJA: Sorata, 2700 m., *Mandon* 1174 e. p. (P; type); Unduavi, 3200 m., *Buchtien* 2599 (NY). COCHABAMBA: CHAPARE: Llanta Aduana, Colomi to Cochabamba, 3500 m., *Cárdenas* 2253 (GH); Incachaca, 2700 m., *hb. Marnier-Lapostolle s. n.* (US); AYOPAYA: Choro, 3200 m., *Cárdenas* 4382 (US); CERCADO [?]: Yungas, 3300 m., *M. B. Foster* 2547 (US); 3150 m., 2549 (US); CARRASCO: Sehuenka, *Cárdenas* 6166 (US). SANTA CRUZ: VALLE GRANDE: Comarapa, 2800 m., *Steinbach* 8561 (US).

13. **T. biflora** R. & P. Fl. Peruv. **3:** 41, t. 268 (1802). Stemless, to 35 cm. high. Leaves 2 dm. long, obscurely punctulate-lepidote, often purple-spotted, the blades ligulate, acute, 2 cm. wide. Scape slender, usually curved. Scape-bracts densely imbricate, foliaceous. Inflorescence densely bipinnate or rarely reduced to a single polystichous-flowered spike, ovoid, glabrous or obscurely punctulate-lepidote. Primary bracts broadly ovate, thin, inflated, exceeding the lower and middle spikes, the lower attenuate, the upper apiculate. Spikes laxly 1-3-flowered, short-stipitate. Floral bracts broadly ovate, much shorter than the sepals, carinate, nerved, thin. Sepals oblong, obtuse or broadly acute, 12-15 mm. long, subfree, carinate, nerved. Petals ligulate, 2 cm. long, blue to purple. Stamens included. WITHOUT DEPARTMENT: *Bang* 1802 (F, GH, NY, US; distributed as "*Guzmania tricolor*"); LA PAZ: LARECAJA: Sorata, 2700 m., *Mandon* 1174 in part (S). Peru to Venezula.

14. **T. fusco-guttata** Mez in Bull. Herb. Boiss. (ser. 2) **5:** 101 (1905). Stemless, flowering 4-6 dm. high. Leaves 2-4 dm. long, the blades ligulate, acute or attenuate, 15-40 mm. wide, obscurely brown-punctulate, spotted. Scape erect or curved. Scape-bracts imbricate, foliaceous. Inflorescence densely bipinnate or interrupted at base, subpyramidal, 6-12 cm. long, 4-5 cm. in diameter. Primary bracts ovate-elliptic, long-laminate with recurving apices, exceeding the middle and lower spikes, punctulate. Spikes ovate-elliptic, acute, 25-30 mm. long, 12-15 mm. wide, complanate, densely 6-7-flowered. Floral bracts broadly ovate, equaling or slightly shorter than the sepals, carinate, glabrous, slightly nerved, subcoriaceous. Sepals obtuse, 10 mm. long, equally subfree, coriaceous. Petals 16 mm. long, blue. Stamens included. COCHABAMBA: AYOPAYA: Sailapata, 2700 m., *Cárdenas* 3030 (GH, US). Province [?]: Monte Punco, 3000 m., *Cárdenas* 5276 (US). CHAPARE: Chapare, 2000 m., *Cárdenas* 6055 (US). Peru.

15. **T. sphaerocephala** Baker in Journ. Bot. **26:** 141 (1888). Stemless, flowering to 2 dm. high. Leaves 2-4 dm. long, covered with ap-

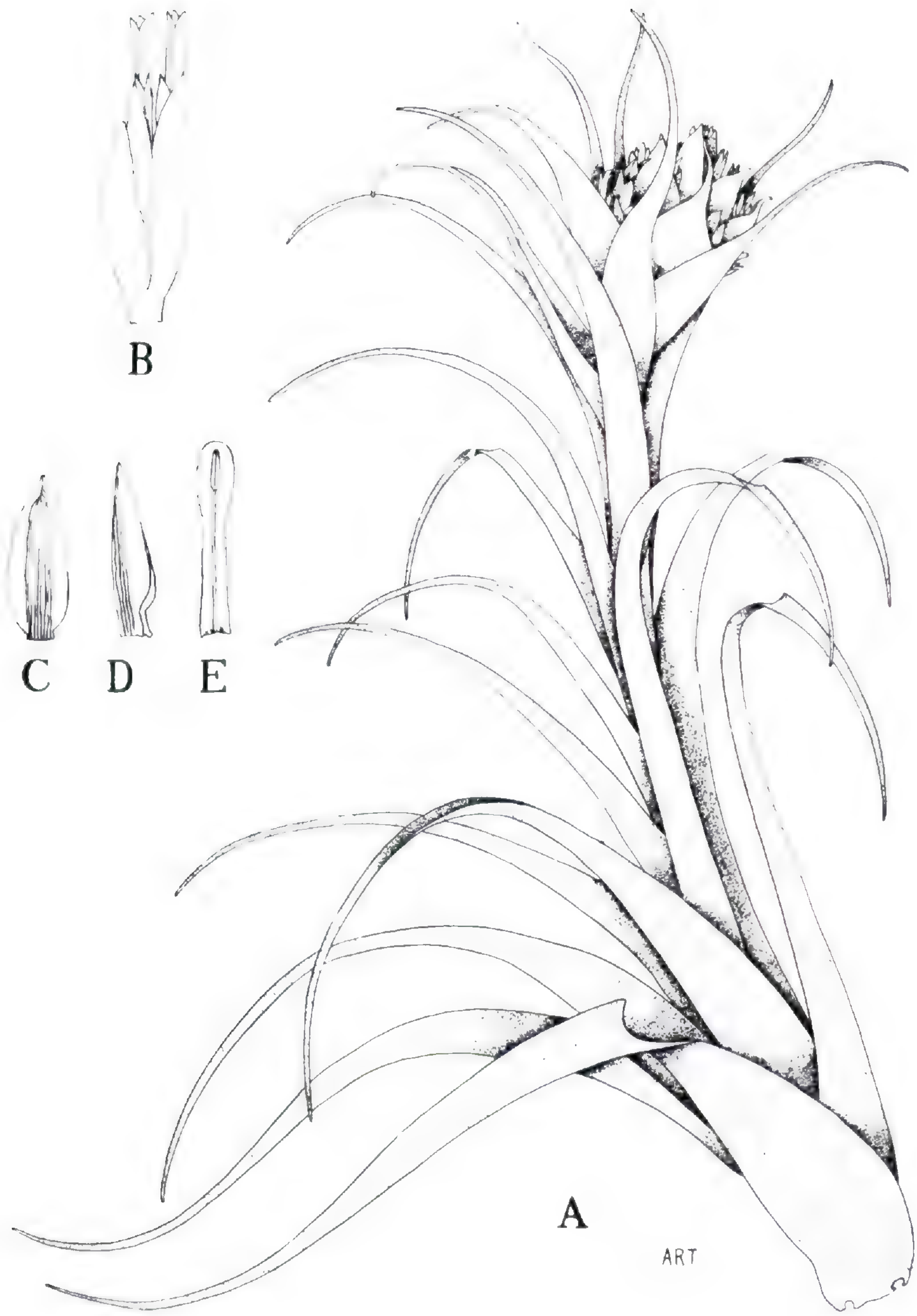

Figure (2)

A: *Tillandsia sphaerocephala* (after *Bang* 159); habit × 1/2; **B**: spike × 1; **C**: anterior sepal × 1; **D**: posterior sepal × 1; **E**: petal and stamen × 1.

pressed lustrous scales, the blades narrowly triangular, 2 cm. wide, involute-subulate toward apex, erect or decurved. Scape usually curved and ascending. Scape-bracts densely imbricate, foliaceous. Inflorescence bipinnate, densely capitate, 5-6 cm. long. Outer primary bracts with a broad ovate base and long triangular apex that exceeds the inflorescence, the inner ovate, obtuse, apiculate, equaling the spikes. Spikes 1-2-flowered, strongly complanate. Floral bracts ovate, 23-30 mm. long, carinate, sparsely lepidote to glabrous, strongly nerved. Sepals ovate, acute, 20-25 mm. long, carinate. Posteriorly connate for 3 mm. Petals to 30 mm. long. Stamens included. LA PAZ: MURILLO: La Paz, 3000 m., *Bang* 159 (GH, NY, US); *Rusby* 2848 (NY); Obrajes, 3550 m., *Buchtien* 4540 (US); 3300 m., 6384 (US); 3600 m., *Cárdenas* 2419 (GH); San Jorge, 3550 m., *Buchtien* 8819 (US); LARECAJA: Sorata, 3100 m., *Mandon* 1188 (K; type); MUÑECAS: Charazani, 2700 m., *Cárdenas* 3867 (GH); INQUISIVI: Pongo de Quime, 3000 m., *White* 182 (NY). COCHABAMBA: CERCADO: Tunari, 1950 m., *M. B. Foster* 2534 (US). Fig. 2.

16. **T. calocephala** Wittm. in Meded. Rijks Herbar. **29**: 90 (1916). Caulescent, flowering 22 cm. long. Leaves 6-10 cm. long, covered with subappressed cinereous scales, the blades narrowly triangular, subulate-attenuate, 10-12 mm. wide, more or less secund-recurving. Scape very short, Scape-bracts foliaceous and only slightly reduced. Inflorescence densely bipinnate, ovoid, 25 mm. long, 15-20 mm. in diameter. Primary bracts suborbicular, slightly shorter to slightly longer than the spikes, the lowest foliaceous-laminate. Spikes sessile, lanceolate, 2-3-flowered, complanate. Floral bracts imbricate, lance-ovate, 10 mm. long, slightly shorter than the sepals, carinate, thin, nerved, lepidote. Sepals lanceolate, 12 mm. long, carinate, glabrous, short-connate posteriorly. Petals 15 mm. long, violet. Stamens included. LA PAZ: MURILLO: La Paz, *Shepard* 234 (GH). COCHABAMBA: CHAPARE[?]: Rio Montehuaiko, *Herzog* 2300 (L; type). Peru.

17. **T. Walteri** Mez in Fedde, Repert. Spec. Nov. **3**: 43 (1906). Stemless, flowering 5 dm. high. Leaves cinereous-lepidote, the sheaths ovate, longer than the blades, the blades lanceolate, attenuate, 2 dm. long, 4 cm. wide. Scape erect, stout. Scape-bracts imbricate, the lower ones caudate. Inflorescence simple, dense, distichously 12-16-flowered, lanceolate, 2 dm. long, 4 cm. wide, slightly complanate. Rhachis straight, alate, glabrous. Floral bracts imbricate and concealing the rhachis, broadly elliptic, obtuse, 5 cm. long, exceeding the sepals, inflated, ecarinate, nerved, glabrous. Pedicels stout, 4 mm. long. Sepals equally subfree, obtuse, 40 mm. long, nerved, glabrous. Petals 60 mm. long, violet. Stamens included. COCHABAMBA: AYOPAYA: Sailapata, 2500 m., *Cárdenas* 3312 (GH). Peru.

18. **T. complanata** Benth. Bot. Voy. Sulphur, 173 (1846). Leaves many in a dense rosette, 3-4 dm. long usually, mostly exceeding the

inflorescences, spotted, streaked, or suffused with dark purple especially toward base, the blades ligulate, abruptly acute or subobtuse, 3-5 cm. wide, obscurely punctulate-lepidote. Scapes many and axillary, at length decurved with the leaves, 1-2 mm. in diameter, glabrous. Scape-bracts erect, usually imbricate, narrowly lanceolate, subchartaceous, glabrous or nearly so. Inflorescences simple, lanceolate or linear, acute, dense, to 8 cm. long, 15-20 mm. wide, usually complanate, glabrous. Floral bracts elliptic, obtuse, 15-25 mm. long, exceeding the sepals, even or nerved, ecarinate. Flowers subsessile. Sepals lanceolate, acute, 10-15 mm. long, the posterior ones carinate, usually much connate. Petals ca. 2 cm. long, rose, purple, or blue. Stamens included. LA PAZ: MURILLO: La Paz, 3000 m., *Rusby* 2855 (NY); LARECAJA: Mapiri, San Carlos, Sarampiuni, 600 m., *Buchtien* 372 (NY); Hacienda Casana, Tipuani, 1400 m., *Buchtien* 7186 (US). COCHABAMBA: CHAPARE: Antahuacana, Espíritu Santo, 750 m., *Buchtien* 2253 (US); Locotal, 1700 m., *Steinbach* 9596 (GH). Peru to Costa Rica and the West Indies.

19. **T. Cardenasii** L. B. Smith in Proc. Amer. Acad. **70:** 154 (1935). Caulescent, flowering 20-25 cm. high. Stem to 1 dm. long, simple. Leaves to 2 dm. long, the blades linear-triangular, filiform-attenuate, 8 mm. wide, densely villous-lepidote with basally produced cinereous scales, involute. Scape erect, 1 mm. in diameter, glabrous. Scape-bracts lanceolate, exceeding the internodes, dark purple, appressed-lepidote, foliaceous-laminate. Inflorescence simple, lanceolate, 5 cm. long, 1 cm. wide, complanate, densely 4-7-flowered. Floral bracts like the scape-bracts but glabrous, 27 mm. long, ecarinate, submembranaceous. Flowers subsessile. Sepals lanceolate, attenuate, 20 mm. long, free, glabrous, nerved. Petals ligulate, lilac. Stamens included. CHUQUISACA: PROVINCE [?]: Cerro Macho, 2730 m., *Cárdenas* 491 (GH; type).

20. **T. ixioides** Griseb. in Goett. Abh. **24:** 333 (1879). More or less caulescent, flowering 1-3 dm. high. Leaves many, 10-18 cm. long, covered with appressed cinereous scales, the blades very narrowly triangular, 10 mm. wide, deeply channeled becoming involute toward apex. Scape erect or ascending, equaling or exceeding the leaves, slender, glabrous. Scape-bracts imbricate, ovate, subacute, thin, stramineous, lepidote. Inflorescence simple, of 3-7 polystichous flowers, sublax, 45 mm. long. Floral bracts suberect, broadly ovate or elliptic, subacute, ca. 20 mm. long, exceeded by the sepals, thin, stramineous, lepidote toward apex. Pedicels stout, to 5 mm. long. Sepals ovate, acute, to 19 mm. long, connate more highly posteriorly, carinate, nerved, glabrous. Petals to 34 mm. long, yellow, the blade elliptic. Stamens included, the filaments straight. CHUQUISACA: TOMINA: 2200 m., *Cárdenas* 4093 (GH, US). Paraguay, Uruguay, Argentina.

21. **T. xiphioides** Ker-Gawl. in Bot. Register, **2:** t. 105 (1816). *T. Friesii* of Catalogue, non Mez. Flowering 15-30 cm. or higher. Stem from very short to 15 cm. long, simple to few-branched. Leaves many, polystichous but sometimes almost distichous, curved or contorted, to 25 cm. long, covered with cinereous or ferruginous subspreading scales, the blades narrowly triangular, subulate-attenuate, flat, to 2 cm. wide. Scape from almost none to 12 cm. long. Scape-bracts densely imbricate, elliptic-oblong, thin, the lower ones caudate and lepidote, the upper apiculate and nearly or quite glabrous. Inflorescence simple, of 2-10 distichous flowers, lance-oblong, acute, to 12 cm. long. Floral bracts densely imbricate, lance-oblong, acute, to 7 cm. long, much exceeding the sepals, submembranous, ecarinate, nearly or quite glabrous. Flowers to 10 cm. long. Sepals linear-lanceolate, attenuate, to 42 mm. long, free, glabrous, thin, nerved. Petals white, fragrant, the blade broadly elliptic, obtuse, spreading, 2 cm. wide, crenate-serrate. Stamens barely included or exserted from the throat of the corolla, the filaments straight. POTOSI: NOR CHICHAS: San Antonio, *Cárdenas* 93 (GH). Brazil, Uruguay, Argentina.

22. **T. Lorentziana** Griseb. in Goett. Abh. **19:** 217 (1874). *T. Lorentziana* var. *simplex* O. Ktze. Rev. Gen. **3** (2) : 304 (1898). Caulescent, flowering 2-7 dm. high. Leaves 2-4 dm. long, the blades very narrowly triangular, to 20 mm. wide, covered with spreading cinereous or brownish scales, often carinate, the margins coarsely ciliate-lepidote. Scape erect, slender. Scape-bracts imbricate and usually covering the scape, the lower foliaceous, the upper lanceolate, acute, densely lepidote. Inflorescence laxly bipinnate or sometimes simple, usually 12-15 cm. long with 4-8 spikes. Primary bracts like the upper scape-bracts, much shorter than the spikes. Spikes divergent, straight, oblong-lanceolate, 6 cm. long, 15 mm. wide, strongly complanate, the bracts of the sterile base as large as the floral bracts. Rhachis flexuous, slender, angled, glabrous. Floral bracts suberect, imbricate but exposing the rhachis, acute, mostly 20-25 mm. long, slightly exceeding the sepals, ecarinate, papyraceous, glabrous or nearly so. Sepals oblong, acute, 16-18 mm. long, subfree. Petals 35 mm. long, white. Stamens included, the filaments plicate. COCHABAMBA: CERCADO: Tunari, *Kuntze* s. n. (NY; type of *T. Lorentziana* var. *simplex* O. Ktze.) ; PROVINCE [?] : Abra de Sacaba, 2600 m., *Cárdenas* 2211 (GH) ; QUILLACOLLO: Cerro del Calvario, 2560 m., *Cárdenas* 3577 (GH). SANTA CRUZ: VALLE GRANDE: Pampa Grande, 1200 m., *Steinbach* 6034a (F, GH). Brazil, Paraguay, Argentina.

23. **T. caulescens** Brongn. ex Baker, Handbk. Bromel. 168 (1889). Plant to 45 cm. long. Stem much branched, to 30 cm. long. Leaves very many, rigid, arching and secund or strict, 10-15 cm. long, densely appressed- or subpruinose-lepidote, the blades narrowly tri-

angular, 5 mm. wide, involute, usually with a strong median ridge beneath. Scape distinct to almost none. Scape-bracts densely imbricate, the lower ones foliaceous, the upper elliptic, acute or apiculate, nerved, roseate, more or less lepidote. Inflorescence simple, distichously 14-flowered or less, linear or linear-lanceolate, acute, 5-7 cm. long, 10-12 mm. wide, strongly complanate. Floral bracts densely imbricate but partially exposing the rhachis, lance-ovate, acute, 15-20 mm. long, exceeding the sepals, ecarinate, subcoriaceous, glabrous, roseate. Sepals lanceolate, acute, 15 mm. long, equally subfree or connate posteriorly to 3 mm. Petals white, 25 mm. long. Stamens included, the filaments plicate. LA PAZ: SUR YUNGAS [?]: Rio Bopi Basin, 1000 m., *Rusby* 670 (NY); San Bartolome, Calisaya, 750-900 m., *Krukoff* 10042 in part (MICH); *White* 536 (NY); alt. 500 m., *White* 1068 (K, NY). Peru.

24. **T. didisticha** Baker in Journ. Bot. **26:** 16 (1888). *T. crassifolia* Baker, Handbk. Bromel. 174 (1889). *Guzmania complanata* Wittm. of Catalogue. Stemless, flowering 25-35 cm. high. Leaves 1-3 dm. long, the blades very narrowly triangular, channeled, 6-20 mm. wide, covered with subappressed cinereous scales. Scape erect, slender. Scape-bracts covering the scape, elliptic, acute, densely lepidote. Inflorescence bipinnate or at base subtripinnate, dense, fan-shaped with all the spikes in one plane, 6-14 cm. long. Primary bracts erect, nearly imbricate, like the scape-bracts, much shorter than the spikes. Spikes curved-spreading from an erect base, narrowly lanceolate, 3-8 cm. long, strongly complanate, the sterile base with imbricate reduced bracts. Floral bracts imbricate and covering the rhachis, ovate, acute, 11-15 mm. long, equaling the sepals, carinate, thin, strongly nerved, densely cinereous-lepidote to nearly glabrous. Sepals narrowly lanceolate, acuminate, slightly connate posteriorly. Petals 15-20 mm. long, white. Stamens included, the filaments plicate. BENI: CERCADO MOJOS: Trinidad to Missiones Guarayos, 250 m., *Werdermann* 2357 (MO). LA PAZ: CAUPOLICÁN: Apolo, 1440 m., *Williams* 1484 (K, NY); NOR YUNGAS: Milluguaya, 900 m., *Buchtien* 4286 (US); SUR YUNGAS: San Bartolome, Calisaya, Río Bopi Basin, 750-900 m., *Krukoff* 10045 e. p. (F). COCHABAMBA: AYOPAYA: Santa Rosa, 2000 m., *Cárdenas* 4376 (US). CHUQUISACA: AZERO: Camatinga, Machareti, *Herzog* 1201 (L; type of *Guzmania complanata* Wittm.). SANTA CRUZ: CERCADO: Santa Cruz, 1000 m., *Kuntze* (NY); CHIQUITOS: *Castelnau* 2 (P; type of *T. crassifolia* Baker); Roboré de Chiquitos, 416 m., *Cárdenas* 2958 (GH); Santiago de Chiquitos 700 m., *Cutler* 7027 (GH); SARA: Buena Vista, 450 m., *Steinbach* 6664 (S). Brazil, Paraguay, Argentina.

25. **T. vernicosa** Baker in Journ. Bot. **25:** 241 (1887). *T. polyphylla* Baker of Catalogue. Stemless, flowering to 3 dm. high. Leaves to 18 cm. long, covered with tightly appressed fine scales, the blades

very narrowly triangular, rigid, 20 mm. wide, deeply channeled. Scape erect, equaling or shorter than the leaves. Scape-bracts densely imbricate, broadly elliptic, lepidote, the lower short-laminate, the upper rounded. Inflorescence digitate from 3-5 spikes, to 7 cm. long. Primary bracts like the upper scape-bracts, much shorter than the spikes. Spikes erect, sessile, narrowly lanceolate, 10 cm. long, 9 mm. wide, complanate, densely 20-flowered. Floral bracts broadly elliptic, obtuse, 10 mm. long, about equaling the sepals, ecarinate, nearly or quite even, coriaceous, lepidote at apex, rose when dry. Sepals elliptic, obtuse, free, rigid, even, glabrous. Petals 20 mm. long, white. Stamens included, the filaments plicate. LA PAZ: LARECAJA: Sorata, San Pedro, 2550 m., *Mandon* 1183 (P; type of *T. polyphylla* Baker). CHUQUISACA: ORIENTE: Charagua, 800 m., *Cárdenas* 2689 (F, GH). SANTA CRUZ: CERCADO: Sierra de Santa Cruz, *Kuntze* (NY); VELASCO: 200 m., *Kuntze* (NY); San José de Chiquitos, 255 m., *Cutler* 7084 e. p. Paraguay, Argentina.

26. **T. tenuifolia** L. Sp. Pl. 286 (1753). *T. pulchella* Hook. of Catalogue. *T. pulchella* var. *rosea* of Catalogue, non *T. rosea* Lindl. More or less caulescent with stem to 25 cm. long, often branching and associated in great mats, rather variable. Leaves 5-10 cm. long, typically exceeding the inflorescence, densely and minutely appressed-lepidote throughout, the blades narrowly triangular, subulate-attenuate, 2-7 mm. wide, channeled. Scape erect or ascending, slender, short. Scape-bracts imbricate, elliptic, caudate, membranaceous, rose. Inflorescence simple, polystichous-flowered, ovoid, densely 4-10-flowered. Floral bracts like the scape-bracts but suborbicular and less caudate, much exceeding the sepals. Sepals lanceolate, acute, 10 mm. long, much connate posteriorly, membranaceous, glabrous. Petals 20 mm. long, blue, white, or rose. Stamens included, the filaments plicate. LA PAZ: LARECAJA: Sorata, 2650 m., *Mandon* 1184 (S); *Bang* 1628 e. p. (G, GH); NOR YUNGAS: Polo-polo, Coroico, 1100 m., *Buchtien* 3672 (US); INQUISIVI: Quimes, 2400 m., *White* 218 (NY). COCHABAMBA: CERCADO: Tunari, *Kuntze* (NY); CHUQUISACA: CHARCAS: Santiago, 950 m., *I. S. Nelson* 58-455 (US); TOMINA [?]: Bartolo, Monteagudo to Sucre, 1350 m., *Brooke* 5684 (NY). SANTA CRUZ: VALLE GRANDE: Samaipata, 1800 m., *Cárdenas* 3521; 1500 m., *Cárdenas* 4604 (US). West Indies to Argentina.

27. **T. Pohliana** Mez in Mart. Fl. Bras. **3** (3): 597, t. 111 (1894). Stemless or short-caulescent, flowering 15-36 cm. high. Leaves few or many, rosulate, to 28 cm. long, covered with spreading cinereous scales; sheaths small, narrow and indistinct; blades very narrowly triangular, 1-2 cm. wide, strongly channeled. Scape erect, more or less curved, slender. Scape-bracts imbricate and covering the scape, the lower foliaceous, the upper elliptic with narrow blades. Inflorescence simple with a few polystichous flowers, dense or subdense, 35-

95 mm. long, densely cinereous-lepidote except the petals. Floral bracts suberect to spreading, broadly elliptic, inflated, exceeding the flowers, the lower caudate. Flowers subsessile. Sepals free, very broadly elliptic or suborbicular, apiculate, broadly convex, 11-15 mm. long, thick, coriaceous. Petals obtuse, 18-22 mm. long, white. Stamens included. SANTA CRUZ: VELASCO: San Ignacio, *I. S. Nelson* 58-G-14 (US). Brazil, Paraguay, Argentina.

28. **T. laxissima** Mez in Bull. Herb. Boiss. (ser. 2) 5: 108 (1905). Leaves many in a dense rosette, 3 dm. long, the blades ligulate or slightly contracted at base, acute, 3 cm. wide, chartaceous, minutely appressed-lepidote. Scape unknown. Inflorescence diffusely tripinnate, the axes slender, glabrous. Primary bracts spreading, lance-ovate, shorter than the sterile bases of the branches. Spikes linear, 9 cm. long, very laxly 8-16-flowered. Floral bracts elliptic, obtuse, 7 mm. long, ecarinate, subcoriaceous, nerved, glabrous. Flowers spreading, sessile. Sepals subsymmetric, narrowly elliptic, obtuse, 13 mm. long, subequally short-connate, coriaceous, nerved, glabrous. Capsule slenderly cylindric, abruptly acute, 35 mm. long. WITHOUT DEPARTMENT: *Bang* 2301 in part (GH, NY, US; type-number).

29. **T. Duratii** Vis. in Nuov. Sagg. Padov. 5: 271 (1840). Caulescent, flowering, 2-6 dm. long. Stem stout, curved, simple, to over 1 m. long. Leaves to 45 cm. long, covered with coarse subappressed cinereous scales, the blades very narrowly triangular, spirally recurved and grasping branches of trees, 20 mm. wide, involute-subulate, rigid, thick. Scape erect, stout. Scape-bracts imbricate, elliptic, densely cinereous-lepidote, the lower linear-laminate, the upper apiculate. Inflorescence 2-3-pinnate or rarely simple, 60 cm. long. Primary bracts like the upper scape-bracts, erect and sometimes exceeding the lower spikes. Spikes strict or curved outward at apex, lanceolate or linear-lanceolate, 3-8 cm. long, 1 cm. wide, complanate, subdense. Floral bracts erect, enfolding the base of the flower and exposing the rhachis, elliptic, exceeded by the sepals, ecarinate, coriaceous, densely lepidote in the typical variety. Sepals elliptic, 14 mm. long, unequally short-connate, coriaceous, even, glabrous. Petals 30 mm. long, the blades rhombic-orbicular, 16 mm. long, blue. Stamens deeply included, exceeding the pistil. TARIJA: CHACO: Villamontes, Yaquacuna, *Troll* 387 (B); PROVINCE ?: *Weddell* 4035 in part (P). Paraguay, Argentina, Uruguay.

29a. T. **Duratii** var. **saxatilis** (Hassler) L. B. Smith in Phytologia, 16: 78 (1968). *T. decomposita* Baker, Handbk. Bromel. 168 (1889). *T. Weddellii* Baker of Catalogue. *T. confusa* Hassler var. *saxatilis* Hassler in Ann. Conserv. & Jard. Bot. Genève, 20: 329 (1919). Floral bracts nearly or quite glabrous, lustrous. LA PAZ: LOAIZA: Teneria, 3000 m., *Herzog* 2488 (L). COCHABAMBA: AYOPAYA: Santa Rosa, 2000 m., *Cárdenas* 4375 (US); CERCADO: Tunari, *Kuntze* (NY, US). CHU-

QUISACA: ORIENTE: Charagua, 800 m., *Cárdenas* 2792 (F, GH). SANTA CRUZ: VELASCO: West Velasco, 200 m., *Kuntze* (NY). TARIJA: *Province* [?]: *Weddell* 4035 in part (P; type of *T. Weddellii* Baker). Paraguay, Argentina, Uruguay.

30. **T. Reichenbachii** Baker, Handbk. Bromel. 166 (1889). *T. tucumanensis* Mez of Catalogue. *T. Herzogii* Wittm. of Catalogue. Caulescent, flowering over 2 dm. high but usually much smaller. Leaves to 14 cm. long, the blades recurving but not spiraling, very narrowly triangular, involute-subulate, 8 mm. wide, covered with subappressed cinereous scales. Scape erect, slender. Scape-bracts imbricate, sublanceolate, subacute, nerved, lepidote. Inflorescence compactly bipinnate from 2-8 spikes or sometimes simple, to 70 mm. long, 45 mm. wide. Primary bracts like the scape-bracts but obtuse, shorter than the spikes. Spikes subsessile, erect to somewhat decurved, linear, acute, 30 mm. long, 9 mm. wide, densely 5-7-flowered, complanate. Floral bracts enfolding the flowers and exposing the rhachis, elliptic, obtuse, shorter than the sepals, nerved, glabrous, sublustrous. Sepals elliptic, rounded, 12 mm. long, unequally short-connate, subcoriaceous, even, glabrous. Petal-blades suborbicular, 7 mm. long, blue-violet. Stamens deeply included, exceeding the pistil. SANTA CRUZ: CORDILLERA: Cumbarute, 800 m., *Herzog* 1151 (L; type of *T. Herzogii* Wittm.); ORIENTE: Charagua, 800 m., *Cárdenas* 2682 (GH). CHUQUISACA: TOMINA: Montecanto, 2000 m., *Troll* 77-A (B). TARIJA: CHACO: Curuenda, 200 m., *Cárdenas* 2532 (F, GH). Argentina.

31. **T. streptocarpa** Baker in Journ. Bot. **25:** 241 (1887). *T. soratensis* Baker of Catalogue. *T. condensata* Baker of Catalogue. *T. apoloensis* Rusby of Catalogue. Flowering 1-5 dm. high. Stem 1 dm. to almost lacking. Leaves 8-50 cm. long, covered with slender spreading cinereous scales, the blades spreading or recurved, linear-triangular, long-attenuate, to 15 mm. wide at base, involute-subulate. Scape erect, slender, nearly glabrous. Scape-bracts imbricate, lanceolate, acute, densely lepidote, nerved, the lowest with slender foliaceous blades. Inflorescence bipinnate from 2-12 spikes or rarely simple. Primary bracts like the upper scape-bracts, erect, much shorter than the spikes. Spikes linear to elliptic, arched-spreading from an erect densely bracteate sterile base, complanate, 3-12-flowered. Floral bracts lanceolate, acute or subobtuse, slightly shorter than the sepals, nerved, lepidote or glabrous. Flowers erect. Sepals free or very short-connate, oblong, broadly acute or obtuse, 10-13 mm. long, glabrous. Petals ca. 25 mm. long, the blades spreading, very broadly obovate, blue or purple. Stamens deeply included, exceeding the pistil. LA PAZ: LARECAJA: Sorata, 2600 m., *Mandon* 1185 (K; type of *T. soratensis* Baker); INQUISIVI: Suri, 2400 m., *White* 229 (NY); CAUPOLICÁN: Apolo, 1440 m., *Williams* 1483 (NY; type of *T. apoloensis* Rusby); CERCADO: [?]: Río La Paz, 1180 m., *I. S. Nelson* 387 (US). COCHABAMBA: AYOPAYA:

Sailapata, 2500 m., *Cárdenas* 3305 (GH); CERCADO: Tunari, 1300 m., *Kuntze* s. n. (NY). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 6665 (S, Z); VELASCO: West Velasco, 200 m., *Kuntze* s. n. (NY); VALLE GRANDE: San Isidoro, Comarapa, 1700 m., *Vogel* 474 (US). TARIJA: CHACO: Villamontes, Yaquacuna, 500 m., *Troll* 387 in part (B). CHUQUISACA: AZERO: *Weddell* s. n. (P; type of *T. condensata* Baker). Brazil, Paraguay, Uruguay, Argentina, Peru.

32. **T. paleacea** Presl, Rel. Haenk. **1:** 125 (1827). *T. scalarifolia* Baker of Catalogue. Flowering 1-7 dm. long. Stem at least to 35 cm. long, much branched, appearing stout because of the leaf-sheaths. Leaves more than distichous but relatively few-ranked and widely spaced so that the blade and the upper half of the sheath are clearly visible, covered with slender cinereous or finally fuscous scales, the blades abruptly spreading, usually contorted, to 12 cm. long, 4-6 mm. wide. Scape erect, slender, from very short to over 15 cm. long, glabrous or nearly so. Scape-bracts imbricate or nearly so, elliptic, apiculate, lepidote, the lower filiform-laminate. Inflorescence simple, lanceolate with 1-12 distichous flowers, acute, to 5 cm. long, dense, complanate. Floral bracts ovate or elliptic, about equaling the sepals, ecarinate, sulcate, soon glabrous. Sepals lanceolate, 10-17 mm. long, free, glabrous. Petal-blade spreading, suborbicular, blue or violet. Stamens deeply included, exceeding the pistil. BOLIVIA: *Pentland* s. n. (K; type of *T. scalarifolia* Baker). LA PAZ: LOAIZA [?]: La Granja, 2600 m., *Julio* 158 (BM, US). Chile, Peru, Colombia.

33. **T. crocata** (E. Morr.) Baker in Journ. Bot. **25:** 214 (1887). *T. Mandonii* Morr. ex Mez of Catalogue. Flowering 15-35 cm. long. Stem simple or few-branched, to 2 dm. and longer. Leaves distichous, 1-3 dm. long, covered with fine narrow reflexed scales, the blades spreading or recurving, linear, long-attenuate, 2-5 mm. in diameter. Scape terminal, erect or nearly so, slender, 5-15 cm. long, retrorse-tomentose like the leaves, naked or with a single foliaceous bract. Inflorescence always simple and distichous-flowered, lanceolate or elliptic, acute, 1-4 cm. long, dense, 2-6-flowered. Floral bracts ovate, acuminate, to 2 cm. long, about equaling the sepals, densely tomentose-lepidote. Flowers fragrant. Sepals sublanceolate, broadly acute or obtuse, thin, nerved, densely appressed-lepidote except in extreme age. Petals to 2 cm. long, the blade suborbicular, obtuse, 6-8 mm. wide, bright yellow. Stamens deeply included, exceeding the pistil. LA PAZ: LARECAJA: San Pedro to Coaconi, 2650 m., *Mandon* 1180 (K; type of *T. Mandonii* Morr. ex Mez; BM, GH, S). Brazil, Uruguay, Argentina.

34. **T. bandensis** Baker in Journ. Bot. **25:** 234 (1887). *T. pilosa* L. B. Smith in Phytologia **7:** 175 (1960). Flowering 1-2 dm. long. Stem much branched, 4-6 dm. long. Leaves densely distichous, 5-7 cm. long, densely pruinose- or tomentose-lepidote, the blades suberect

to spreading, linear, involute, long-attenuate, 1-2 mm. in diameter. Scape terminal, erect or decurved, to 9 cm. long, ca. 0.5 mm. in diameter, lepidote at least toward base. Scape-bracts 1-2, remote, elliptic, the upper acute or apiculate, the lower usually filiform-laminate and appressed-lepidote. Inflorescence simple with 2-4 distichous flowers, linear-lanceolate, 2-3 cm. long, 3-5 mm. wide. Floral bracts not imbricate, ovate-elliptic, acute, 9-12 mm. long, the lower ones equaling or shorter than the sepals and sometimes sparsely lepidote. Flowers erect, appressed to the rhachis. Sepals subelliptic, acute, equally subfree, thin, nerved, glabrous. Petals 15-16 mm. long, the blade broadly elliptic or obovate, 5 mm. long, blue or violet. Stamens deeply included, exceeding the pistil. SANTA CRUZ: VALLE GRANDE: Cerro de Alto-Mairana, 2000 m., *Steinbach* 6039; FLORIDA: Saipina, 1800 m., *Cárdenas* 5513 (US; type of *T. pilosa* L. B. Smith).

35. **T. loliacea** Mart. ex Schult. f. Syst. Veg. **7:** 1204 (1830). *T. quadriflora* Baker of Catalogue. Stem simple or branched, rarely more than 4 cm. long. Leaves densely polystichous, 2-3 (-4) cm. long, densely and coarsely pruinose-lepidote, the blades erect to suberect or arching-secund, very narrowly triangular, 3-5 mm. wide. Scape terminal, straight or curved, to 10 cm. long, less than 1 mm. in diameter, lepidote. Scape-bracts many, about equaling the internodes, elliptic, acute, nerved, densely lepidote. Inflorescence simple, linear with up to 16 distichous flowers, to 4 cm. long, lax. Rhachis strongly geniculate, excavated next the flowers, lepidote. Floral bracts not imbricate, closely enfolding the flowers, ovate, acute, equaling or shorter than the sepals, thin, nerved, densely lepidote. Flowers erect and appressed to the rhachis. Sepals lanceolate, acute, to 9 mm. long, glabrous, nerved, equally short-connate. Petals 10 mm. long, pale violet (! Mez) to yellow, the blade narrow, acute. Stamens deeply included, exceeding the pistil. BOLIVIA: *Mandon* 1176 (! Mez); COCHABAMBA: AYOPAYA: *Weddell* 4175 (P). SANTA CRUZ: CHIQUITOS: San José de Chiquitos, 255 m., *Cutler* 7083 (GH); ORIENTE: Charagua, 800 m., *Cárdenas* 2681 (GH); VELASCO: 200 m., *Kuntze* s. n. (NY). Brazil, Paraguay, Argentina, Peru.

36. **T. tricholepis** Baker in Journ. Bot. **26:** 42 (1888). Plant moss-like. Stems many from a single point, densely massed, at first bearing flowers when short and simple but later elongate and much branched, to 22 cm. long. Leaves densely polystichous, typically to 15 mm. long, the blades narrowly triangular, involute, appressed or slightly divergent, reflexed-tomentose with fine linear-lobate scales. Scapes at first terminal, soon becoming pseudo-axillary by the elongation of the stem, 1-4 cm. long, 0.3-0.5 mm. in diameter, sulcate, soon glabrous. Scape-bracts evenly distributed, nearly or quite equaling the internodes, lanceolate, acute, 5-8 mm. long, thin, lepidote. Inflorescence simple, of 1-5 distichous flowers, narrowly lanceolate, to 17 mm. long.

Floral bracts like the scape-bracts but broadly ovate, enfolding the rhachis for about half their length, slightly shorter than the sepals. Flowers erect, imbricate. Sepals lanceolate, acute, 6.5 mm. long, equally short-connate, thin, glabrous or nearly so. Petals linear, yellow, the blade indistinct, obtuse, spreading. Stamens deeply included, exceeding the pistil. BENI: MOJOS: Trinidad, 250 m., *Werdermann* 2396 (S). LA PAZ: INQUISIVI: Inquisivi to Cañamina, 1700 m., *White* 272 (NY); CAUPOLICÁN: Apolo, *Williams* 1486 (BM, NY, US); LARECAJA: Poquerani, San Pedro near Sorata, 2500-2650 m., *Mandon* 1179 in part (K; type; BM, NY, P, S). SANTA CRUZ: FLORIDA: Comarapa, 2000 m., *Cárdenas* 4386 (US); *Vogel* 473 (US); CERCADO: Sierra de Santa Cruz, *Kuntze* s. n. (NY); ORIENTE: Charagua, 800 m., *Cárdenas* 2013 (GH); Agua Caliente, Charagua, *Cárdenas* 2611 (F, GH); CHIQUITOS: San José de Chiquitos, 255 m., *Cutler* 7084-B (GH). CHUQUISACA: AZERO: Camatindi, near Cumbarute and Woyuywe, Río Parapiti, *Herzog* 1195 (L, Z); VALLE GRANDE: El Palo, 1500 m., *Steinbach* 3805 (GH). TARIJA: O'CONNOR: Villamontes, Tartagal, 500 m., *Pflanz* 2151 (US). WITHOUT LOCALITY: *Pearce* s. n. (BM); *Weddell* 3655 (P). Brazil, Paraguay, Argentina.

36a **T. tricholepis** var. **macrophylla** L. B. Smith in Lilloa, **14:** 98 (1948). Short-caulescent. Leaves to 5 cm. long, the blades very slender. LA PAZ: LARECAJA: Charopampa, Mapiri, 570 m., *Buchtien* 1270 (US; type); NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 4541 (US).

37. **T. bryoides** Griseb. ex Baker in Journ. Bot. **16:** 236 (1878); in Goett. Abh. **24:** 334 (1879). Plant small and with a habit like *Lycopodium Selago*. Stems many from a single point, densely massed, simple or few-branched, rarely more than 5 cm. long. Leaves densely polystichous, 4-6 (-9) mm. long, the blades erect, subtriangular, stout, to 2 mm. wide, densely cinereous-lepidote. Scape often lacking so that the 1-flowered inflorescence is sunk among the terminal leaves, when present evidently elongating only after anthesis, erect, slender, glabrous, naked or with a single lanceolate bract enfolding its extreme base, to 3 cm. long. Inflorescence usually terminal but sometimes becoming pseudoaxillary by the elongation of the stem, always 1-flowered. Floral bract triangular-ovate, 7 mm. long, hyaline with a single median excurrent nerve, glabrous or nearly so. Sepals narrowly elliptic, 5-9 mm. long, hyaline, 3-nerved, equally short-connate. Petals linear, fleshy, sulphur-yellow drying to orange-brown. Stamens deeply included, exceeding the pistil. LA PAZ: MURILLO [?]: Huaricana, 800 m., *Buchtien* 806 (NY, US); MURILLO: Cotaña Illimani, 2450 m., *Buchtien* 4144 (GH); LARECAJA: Sorata, 2500-2650 m., *Mandon* 1179 in part (BM); Sorata, Poqueraria San Pedro, 2400-2600 m., *Mandon* 1179 bis (G); LOAIZA [?]: Chivesi, 4000 m., *Pentland* 29 (P). COCHABAMBA: AYOPAYA: Sailapata, 2500 m., *Cárdenas* 3309 (GH); TARATA

[?]: Parotani, 2400 m., *Kuntze* s. n. (NY). POTOSÍ: PROVINCE [?]: Rio Blanco, 3000 m., *Cárdenas* 318 (US). CHUQUISACA: SUR CINTI: Camataqui, 1800 m., *Cárdenas* 213 (GH). SANTA CRUZ: ORIENTE: Charagua to Izozog, 800 m., *Cárdenas* 2690 (GH); CORDILLERA: Cumbarute and Woyuywe, Río Parapiti, *Herzog* (Herzog). WITHOUT LOCALITY: *Miers* 7592-7592x (BM). Argentina, Peru.

38. **T. funebris** Castellanos in Anal. Mus. Nac. Hist. Nat. Buenos Aires, **37:** 502 (1933). Rarely flowering over 10 cm. long. Stems several from a single point, simple or few-branched, 2-5 cm. long. Leaves densely distichous or polystichous, to 5 cm. long, the blades divergent to reflexed, contorted, triangular-subulate, 2-3 mm. in diameter, densely cinereous-lepidote. Scape distinct, to 5 cm. long, slender, glabrous. Scape-bracts 2, remote, usually a somewhat lepidote one near the base of the scape and a glabrous one near its apex. Inflorescence 1-2-flowered, glabrous. Floral bracts like the upper scape-bract but more ovate, about equaling the sepals, even. Sepals lanceolate, acute, 10 mm. long, equally short-connate. Petals 13 mm. long, coffee-colored drying to dark orange-brown, the blade distinct, subrhombic, obtuse. Stamens deeply included, exceeding the pistil. SANTA CRUZ: ORIENTE: Charagua to Izozog, 800 m., *Cárdenas* 2688 (GH). Paraguay, Argentina.

39. **T. Gilliesii** Baker in Journ. Bot. **16:** 240 (1878). Flowering to over 2 dm. long. Stems many from a single point, forming a dense subglobose mass, simple or few-branched. Leaves densely distichous, 2-8 cm. long, covered with subappressed subsymmetrical cinereous to ferruginous scales, the blades arching-recurved, narrowly triangular, much compressed laterally, attenuate with a very narrow channel above. Scape almost lacking to 13 cm. long, appressed-lepidote, naked or bearing a single lanceolate bract. Inflorescence 1-3-flowered, densely cinereous-lepidote, the rhachis flexuous. Floral bracts erect, lanceovate, acute, to 20 mm. long, about equaling the sepals, not more than twice as long as the internodes, ecarinate, nerved. Sepals oblong-lanceolate, to 16 mm. long, equally subfree. Petals narrow. Stamens deeply included, exceeding the pistil. COCHABAMBA: CERCADO: Arani, 2800 m., *Cárdenas* 2418 (GH). CHUQUISACA: SUR CINTI: Camataqui, 1800 m., *Cárdenas* 214 (GH); CINTI: Puca Khasa near Tacaquira, *Hammarlund* 313 (S). Argentina, Peru.

40. **T. myosura** Griseb. ex Baker in Journ. Bot. **16:** 240 (1878); in Goett. Abh. **24:** 333 (1879). Flowering to over 3 dm. high. Stems many from a single point, forming a dense subglobose mass, simple or few-branched. Leaves densely distichous, 5-17 cm. long, the blades strongly recurved, triangular-subulate, 3-5 mm. in diameter, evenly rounded when fresh with a channel along most of the upper side, covered with cinereous subappressed to reflexed-pruinose scales. Scape always distinct, to 20 cm. long, lepidote or glabrous, naked or with

a single lanceolate lepidote bract well removed from the inflorescence. Inflorescence simple, linear, to 8 cm. long, laxly 1-8-flowered, densely cinereous-lepidote. Floral bracts remote, rarely more than twice as long as the internodes, ovate, attenuate, to 21 mm. long, longer to shorter than the sepals, nerved. Flowers strict. Sepals oblong-lanceolate, 9-15 mm. long, equally subfree, thin. Petals linear, to 20 mm. long, yellowish white. Stamens deeply included, exceeding the pistil. COCHABAMBA: CERCADO: Cochabamba, 2530 m., *Jiminez* 22 (US). POTOSÍ: NOR CHICHAS: Cotagaita, 2600 m., *Troll* 3369 (B). Uruguay, Argentina.

41. **T. recurvata** L. Sp. Pl. (ed. 2) **1:** 410 (1762). Rather variable, flowering 4-23 cm. high. Stems densely massed, simple or few-branched, 1-10 cm. long. Leaves densely distichous, 3-17 cm. long, densely pruinose-lepidote, cinereous or ferruginous, the blades usually recurved, linear, terete, 0.5-2 mm. in diameter, soft with a weak apex. Scape terminal, always distinct, to 13 cm. long, about 0.5 mm. in diameter. Scape-bracts linear-lanceolate, lepidote, 1 or rarely 2 immediately below the inflorescence, sometimes one next the inflorescence and one remote. Inflorescence 1-2(-5)-flowered, dense. Floral bracts like the scape-bracts but smaller, mostly equaling or exceeding the sepals, nerved, densely lepidote. Sepals lanceolate, 4-9 mm. long, free or equally short-connate, usually glabrous. Petals narrow, pale violet or white. Stamens deeply included, exceeding the pistil. BENI: CERCADO MOJOS: Trinidad, 250 m., *Werdermann* 2530 (S). LA PAZ: MURILLO: Cotaña, Illimani, 2450 m., *Buchtien* 4143 (NY); LARECAJA: Sorata, *Mandon* 1177 (GH, NY, S); *Williams* 2424 (BM, NY); Ingenio del Oro, 3000 m., *Rusby* 2165 (NY, US); CAUPOLICÁN: Apolo, *Williams* 1485 (BM, NY, US). SANTA CRUZ: PROVINCE [?]: Achira, 1000 m., *Steinbach* 8224 (GH); SARA: Santa Cruz, 450 m., *Steinbach* 3807 in part (GH); 7452 (BM, F, MO, S); VALLE GRANDE: El Palo, 1500 m., *Steinbach* 3807 in part (GH). Southeastern United States to northern Argentina and Chile.

42. **T. capillaris** R. & P. Fl. Peruv. **3:** 42, t. 271, fig. c (1802). Very variable in both size and form, flowering to 16 cm. high. Stems many from a single point, densely massed, simple or branched. Leaves distichous, 1-4(-9) cm. long, densely and finely pruinose-lepidote, cinereous or ferruginous, the blades erect to spreading, typically linear and less than 2 mm. in diameter, obtuse. Scape typically pseudo-axillary, elongate, slender, always naked, glabrous or nearly so. Inflorescence normally 1-flowered. Floral bracts ovate, acute or apiculate, thin with 5 or more strong nerves, typically soon glabrous, usually equaling or exceeding the sepals. Sepals lanceolate, acute or obtuse, to 8 mm. long, connate posteriorly. Petals narrow with scarcely distinct blade, white, yellow, or brown. Stamens deeply included, exceeding the pistil. LA PAZ: MURILLO: La Paz, *Buchtien* 381 in part

(S); *Claude-Joseph* 1109 (US); *Weddell* 4339 (P); Río Abajo, Huaricana, 2700 m., *Buchtien* 807 (F); Cotaña to Illimani, 2450 m., *Buchtien* 4026 (GH); Obrajes, 3300 m., *Buchtien* 6383 (US); OMASUYOS: Achacache, 4000 m., *Mandon* 1181 (BM). COCHABAMBA: CERCADO: Cochabamba, 2700 m., *Buchtien* 2416 (NY, US); Cala-Cala, *Ehrhorn* (UC); Tunari, 1950 m., *M. B. Foster* 2536 (US); Sacaba, 2500 m., *Cutler* 7427 (GH); PROVINCE [?]: Recoleta, 2560 m., *Cárdenas* 4379 (US). SANTA CRUZ: CERCADO: Santa Cruz, 600 m., *Kuntze* (NY). TARIJA: CERCADO: Tarija, 2000 m., *Cárdenas* 211: 215 (GH); PROVINCE [?]: Escayo, 3600 m., *Fiebrig* 3570 (BM); San Luis, *Pearce* s. n. (BM). Peru, Argentina.

42a. **T. capillaris** forma **incana** (Gill.) L. B. Smith in Proc. Amer. Acad. **70:** 211 (1935). Leaves short and stout, mucronate, appressed and ascending so that they form an almost continuous plane. Scapes evident after anthesis and mostly exceeding the leaves, pseudo-axillary. Floral bracts with at least 5 strong nerves meeting near the apex, glabrous or subglabrous. LA PAZ: MURILLO: Obrajes, 3450 m., *Buchtien* 9364 (GH). COCHABAMBA: CERCADO [?]: Cerro San Pedro, 2600 m., *Jiminez* 23 (US). POTOSÍ: NOR CHICHAS: Chorolque, 3900 m., *Cárdenas* 91 (GH); FRIAS: Potosí, 4000 m., *Cárdenas* 209 (GH). Argentina.

42b. **T. capillaris** forma **cordobensis** (Hieron.) L. B. Smith in Proc. Amer. Acad. **70:** 211 (1935). Leaves widely spaced so that the greater part of each sheath is uncovered. Scapes evident after anthesis, usually terminal, mostly exceeding the leaves. Floral bracts with at least 5 strong nerves meeting near the apex, densely and persistently lepidote. LA PAZ: LARECAJA: Ingenio del Oro, 3300 m., *Rusby* 2165 (F, GH); Sorata, 2600 m., *Mandon* 1177 in part (NY); *Williams* 2424 in part (US); MURILLO: Cotaña to Illimani, 2540 m., *Buchtien* 6380 (US). Argentina.

42c. **T. capillaris** forma **virescens** (R. & P.) L. B. Smith in Proc. Amer. Acad. **70:** 212 (1935). *T. Williamsii* Rusby of Catalogue. Scapes never elongating much even after anthesis, mostly shorter than the leaves. Floral bracts with at least 5 strong nerves meeting near the apex. LA PAZ: MURILLO: La Paz, *Bang* 123 (G, NY, US); *Buchtien* s. n. (US); 107 (GH); 155 in part (US); 381 in part (BM, MO, POM, S); 805 in part (MVM, NY, S, US); 2556 (NY); 9159 (GH); 9160 (GH); 9363 (GH); 9365 (GH); *Jaffuel* 585 (GH); *d'Orbigny* 298 (P); *Pentland* 27 (P); 3300 m., *Rusby* 2164 (F, NY, US); *Weddell* s. n. (P); Obrajes, 3550 m., *Buchtien* 9365 (GH); PACAJES: Ulloma to Callapa, 400 m., *Asplund* 6382 (US); OMASUYOS: Achacache, 4000 m., *Mandon* 1181 (P); ANDES: Las Peñas, *Mandon* 1178 in part (P). ORURO: CERCADO: Cerro de Oruro, *Herzog* 2447 (L); POOPÓ: Pazña, 4200 m., *Buchtien* 1271 (US). COCHABAMBA: CERCADO: Cochabamba, 3000 m., *Kuntze* (NY). POTOSÍ: FRIAS: Potosí, *d'Orbigny*

1493 (P); Aroifilla, 3800 m., *Cárdenas* 4385 (US). TARIJA: CERCADO [?]: Escayache, *Gross* 3373 (B). Peru, Argentina, Chile.

42d. T. **capillaris** forma **Hieronymi** (Mez) L. B. Smith in Proc. Amer. Acad. **70:** 213 (1935). Habit of the typical form. Floral bracts with only 3 strong nerves meeting near the apex, the other nerves if any short and with free apices. LA PAZ: MURILLO: Palca to Illimani, 3600-4300 m., *Hauthal* s. n. (S). SANTA CRUZ: VALLE GRANDE: El Palo, 1500 m., *Steinbach* 3807 in part (GH). TARIJA: CERCADO: Tarija, 2000 m., *Cárdenas* 212 (GH). Argentina.

43. T. **usneoides** L. Sp. Pl. (ed. 2) **1:** 411 (1762). Growing pendent from trees in slender branching strands up to 8 m. long. Roots usually absent. Stem less than 1 mm. thick, sympodial, the internodes 3-6 cm. long with only the extreme base covered by the leaves, curved. Leaves distichous, 5 cm. long, densely lepidote, the blades filiform, less than 1 mm. thick. Scape lacking. Inflorescence reduced to a single flower. Floral bracts ovate, shorter than the sepals, lepidote. Sepals narrowly ovate, acute, to 7 mm. long, thin, nerved, glabrous, equally short-connate. Petals narrow, 9-11 mm. long, pale green or blue. Stamens deeply included, exceeding the pistil. LA PAZ: MURILLO: La Paz, *Buchtien* 155 in part (GH); *Jaffuel* 583 (GH); 3000 m., *Bang* 107 (BM, F, GH, MO, NY); Illimani, *Buchtien* s. n. (BM); Cotaña to Illimani, 2600 m., *Buchtien* 6381 (US); Obrajes, 3300 m., *Buchtien* (F, MO, NY, POM, S); LARECAJA: Sorata, *Mandon* 1102 (NY); *Brooke* 6524 (NY); SUR YUNGAS: Sirupaya, Yanacachi, 2100 m., *Buchtien* 390 (US). COCHABAMBA: CERCADO: Morachata to Cochabamba, *Cutler* 7698 (GH); Tunari, 1300 m., *Kuntze* s. n. (NY). CHUQUISACA: CINTI: Huarinota, 3200 m., *Hammarlund* 375 (S). SANTA CRUZ: FLORIDA: Comarapa, 2000 m., *Steinbach* 8548 (AA, US). South-eastern United States to central Argentina and Chile.

44. T. **Seemannii** (Baker) Mez in DC. Monog. Phan. **9:** 737 (1896). Stemless or short-caulescent. Leaves 10-15 cm. long, the sheaths broadly ovate, dark brown, the blades narrowly triangular, to 8 mm. wide. Scape erect, very slender, usually shorter than the leaves. Scape-bracts suberect, suborbicular, shorter than the internodes. Spikes 1 or 2, densely few-flowered. Floral bracts imbricate, suborbicular, acute or apiculate, 14 mm. long, exceeding the flowers, membranaceous, pale-lepidote. Sepals asymmetric, obtuse, 9.5 mm. long, thin, nerved, lepidote. Petals 12-15 mm. long. Stamens included. COCHABAMBA: CHAPARE: Llanta Aduana, 3500 m., *Cárdenas* 2252 (GH); CERCADO [?]: Yungas, 3300 m., *Foster* 2548 (US). Peru, Ecuador, Colombia.

45. T. **spiculosa** Griseb. in Goett. Nachr. **1864:** 17 (1865). *T. triticea* Burchell ex Baker of Catalogue. *T. micrantha* Baker of Catalogue. Stemless, flowering to 8 dm. high. Leaves 3-4 dm. long, obscurely

punctulate-lepidote, often irregularly purple-spotted, the sheaths large, broadly ovate, dark brown, the blades rounded and apiculate or acute, 2-4 cm. wide. Scape erect, often much exceeding the leaves. Scape-bracts narrowly elliptic, about equaling the internodes or the upper ones slightly shorter. Inflorescence bipinnate or tripinnate, lax. Primary bracts narrowly ovate, much shorter than the branches. Spikes linear, dense, 9 cm. long, 6-9 mm. wide, spreading, usually long-stipitate with sterile bracts at the base. Floral bracts broadly ovate, (5-) 6-9 mm. long, equaling or slightly exceeding the sepals, convex, ecarinate, coriaceous, even, glabrous or nearly so. Sepals asymmetric, elliptic, even, glabrous. Petals orange or yellow. Stamens included. LA PAZ: Yungas 1800 m., *Rusby* 2852 (NY; type of *T. micrantha* Baker); SUR YUNGAS: San Bartolome, Calisaya, 750-900 m., *Krukoff* 10512 (GH, NY); LARECAJA: Copacabana, Mapiri, 850-950 m., *Krukoff* 11155 (NY). SANTA CRUZ: COMARAPA: Yungas de San Mateo, 2500 m., *Steinbach* 8416 (GH). WITHOUT LOCALITY: *Bang* 2301 in part (F, GH). Peru and Brazil to Colombia and Trinidad.

46. **T. monticola** Mez & Sodiro in Bull. Herb. Boiss. (ser. 2) 4: 1135 (1904). Stemless, flowering 7 dm. high. Leaves 3 dm. long, punctulate-lepidote, the sheaths forming a pseudobulb, the blades oblong, acute, 35 mm. wide, rigid when dry. Scape slender, much exceeding the leaves. Scape-bracts elliptic, slightly exceeding the internodes. Inflorescence erect, laxly tripinnate, subthyrsoid, 30 cm. long, 8 cm. wide, glabrous or nearly so. Primary bracts elliptic, exceeding the sterile base of the branch. Branches subdistichously inserted, usually bearing 3 spikes. Spikes oblong, acute, 40 mm. long, 13 mm. wide, laxly 14-flowered, complanate, the rhachis geniculate. Floral bracts not imbricate nor concealing the rhachis at maturity, broadly ovate, ecarinate, 8 mm. long, exceeding the sepals, coriaceous, even, especially the upper ones incurved at apex. Sepals strongly asymmetric, obovate, broadly rounded, 6 mm. long, sparsely lepidote. Petals 7 mm. long. Stamens included. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 367 (NY); 750 m., *Buchtien* 1266 (US). Ecuador.

47. **T. pendulispica** Mez in DC. Monog. Phan. 9: 745 (1896). *T. triangularis* Rusby of Catalogue. Stemless, flowering about 5 dm. high. Leaves 3 dm. long, densely and finely appressed-lepidote, often purple-spotted, the sheaths very large, ovate, forming an ellipsoid pseudobulb, the blades linear or narrowly triangular, attenuate, 8-12 mm. wide. Scape erect, slender, glabrous. Scape-bracts lanceolate, acute, much shorter than the internodes. Inflorescence bipinnate or the lowest branches divided, of 16 spikes or often less. Primary bracts like the scape-bracts but obtuse, usually much shorter than the sterile base of the branch. Spikes narrowly oblong, 5 cm. long, 1 cm. wide, nearly uniform, rather densely 10-20-flowered, the lower

ones long-stipitate and pendulous or arching-decurved, the rhachis geniculate. Floral bracts, suborbicular-ovate, 7 mm. long, exceeding the sepals, ecarinate, submembranaceous, nerved, soon glabrous. Sepals asymmetric, obovate, rounded-emarginate, 5 mm. long, even, soon glabrous. Petal-blades 2 mm. long, yellow. Stamens included. COCHABAMBA: CERCADO: Cochabamba, *Bang* s. n. (NY; type of *T. triangularis* Rusby). Peru, Ecuador.

48. **T. pardina** L. B. Smith in Lilloa, **14:** 98 (1948). Stemless, flowering to 57 cm. high. Leaves to 24 cm. long, densely and minutely pale-lepidote, the blades ligulate, very broadly acute or subrounded and apiculate, 5 cm. wide, flat, dark-spotted. Scape erect, slender. Scape-bracts elliptic, about equaling the internodes, densely pale-lepidote. Inflorescence laxly tripinnate, 33 cm. long, sparsely lepidote. Primary bracts like the scape-bracts, shorter than the sterile bracteate bases of the branches. Branches spreading. Spikes dense or interrupted toward base, 10-17-flowered, the rhachis geniculate. Floral bracts broadly ovate, shorter than the sepals, ecarinate, even. Sepals asymmetric, broadly obovate, 5 mm. long, even. LA PAZ: LARECAJA: Hacienda Casana, Tipuani, 1400 m., *Buchtien* 7183 (US; type).

49. **T. Bakeri** L. B. Smith in Contrib. Gray Herb. **95:** 45 (1931). *T. flexuosa* (Baker) Mez of Catalogue. Stemless or short-caulescent, flowering to 11 dm. high. Leaves 3 dm. long, punctulate-lepidote, thin, the sheaths narrowly ovate-elliptic, dark brown, the blades narrowly triangular, caudate, pale-lepidote. Scape erect, slender. Scape-bracts lance-elliptic, attenuate, the upper ones somewhat shorter than the internodes. Inflorescence erect or pendulous, tripinnate, 40 cm. long, 14 cm. wide, lax, the axes flexuous, slender. Lower branches with a long stipe that equals or exceeds the primary bracts, composed of 2-3 spikes. Spikes oblong, 4-5 cm. long, laxly 8-14-flowered, the rhachis straight or nearly so, densely ferruginous-lepidote. Floral bracts ovate, acute, shorter than the sepals, nerved, ferruginous-lepidote. Sepals asymmetric, elliptic, broadly rounded, 4-5 mm. long, ferruginous-lepidote. Petal-blades 1 mm. long, yellow. Stamens included. LA PAZ: LARECAJA: Anansa, Cerro de Uacani, 2700 m., *Mandon* 1172 (K; type). Peru.

50. **T. parviflora** R. & P. Fl. Peruv. **3:** 41, t. 259 (1802). Stemless, flowering less than 3 dm. high. Leaves subbulbous-rosulate, 15 cm. long, finely pale-lepidote, the sheaths large, broadly ovate to suborbicular, the blades linear, attenuate, 4-8 mm. wide. Inflorescence erect or pendulous, bipinnate, pale-lepidote, the axes slender, flexuous. Primary bracts lanceolate, not more than equaling the sterile base of the branch. Spikes linear, very laxly 6-20-flowered, usually long-stipitate, spreading. Floral bracts ovate, acute, about half as long as the sepals, nerved. Flowers suberect to spreading. Sepals asymmetric, 3-4 mm. long. Petals slightly exceeding the sepals, yellow.

Stamens included. La Paz: sur yungas: Calisaya, Río Bopi, 1800 m., *Cárdenas* 1216; 1376 (GH). Santa Cruz: province [?]: Cerro Hosana, 1400-1900 m., *Steinbach* 3457 (GH); comarapa: Yungas de San Mateo, 2500 m., *Steinbach* 8404 (GH). Peru.

51. **T. adpressa** André, Énum. Bromél. 6 (Dec. 13, 1888); in Rev. Hortic. **60:** 566 (Dec. 16, 1888). Stemless, 2-7 dm. high. Leaves usually forming an ovoid pseudo-bulb, 15-30 cm. long, the sheaths broadly elliptic-ovate, dark brown, the blades narrowly triangular, to 20 mm. wide, densely pale-lepidote. Scape erect or nearly so. Scape bracts from shorter than to exceeding the internodes, narrowly ovate-oblong, long-caudate, densely appressed-lepidote. Inflorescence bipinnate, narrow, erect or arching, the axis straight to geniculate. Primary bracts attenuate to caudate, usually equaling or exceeding the spikes. Spikes 8-12-flowered, typically erect or suberect. Floral bracts shorter than the sepals, ovate, acute, densely tomentose-lepidote. Flowers spreading. Sepals strongly asymmetric, obovate, 5 mm. long. The typical variety not found in Bolivia. Ecuador to Costa Rica.

51a. **T. adpressa** var. **Tonduziana** (Mez) L. B. Smith in Contrib. Gray Herb. **89:** 8 (1930). Spikes spreading or reflexed at maturity. La Paz: larecaja: Tipuani Valley, Hacienda Casana, 1400 m., *Buchtien* 7188 (NY, US). Cochabamba: carrasco: Phaccha, 2700 m., *Cárdenas* 6287 (US); province [?]: "Schuenka" Schuenca?, *Cárdenas* s. n. (US). Peru to Costa Rica.

52. **T. juncea** (R. & P.) Poir. in Lam. Encyc. Suppl. **5:** 309 (1818). Flowering 2-4 dm. high, often propagating by scaly branching rhizomes. Leaves many in a fasciculate rosette, about equaling the inflorescence or shorter, the sheaths triangular-ovate, ferruginous, the blades linear-subulate, filiform-attenuate. Scape erect or ascending. Scape-bracts densely imbricate, lance-elliptic, attenuate, filiform-laminate, densely pale-lepidote. Inflorescence very densely digitate from a few spikes or sometimes reduced to a single densely polystichous-flowered spike, ovoid, rarely over 7 cm. long. Primary bracts like the upper scape-bracts, subinvolucrate below the inflorescence, their sheaths slightly shorter than the lower spikes. Spikes sessile, elliptic or lanceolate, acute, to 4 cm. long, slightly complanate. Floral bracts imbricate, broadly ovate, broadly acute or obtuse, carinate in the distichous-flowered spikes, nearly or quite even, densely lepidote. Sepals lanceolate, acute, 15-20 mm. long, coriaceous, even, glabrous or nearly so, much connate posteriorly. Petals tubular-erect, to 4 cm. long, violet. Stamens and pistil exserted. La Paz: sur yungas: San Bartolome, Calisaya, Rio Bopi Basin, 750-900 m., *Krukoff* 10042 (GH, NY). Cochabamba: cercado: Tunari, *Kuntze* s. n. (NY). Peru to the West Indies.

53. **T. polystachia** L. Sp. Pl. (ed. 2) **1:** 410 (1762). Flowering 20-65 cm. high. Leaves many in a dense subspreading rosette, usually much exceeded by the inflorescence and arched-recurving, covered with fine pale appressed scales, often with a narrow purple margin, the sheaths broadly ovate or elliptic-oblong, large and conspicuous, pale ferruginous toward the base, the blades long-attenuate, 10-25 mm. wide, usually flat. Scape erect or ascending, slender. Scape-bracts foliaceous with erect densely imbricate sheaths and long spreading or recurved blades, green, red, or purple. Inflorescence pinnately or subdigitately compound or very rarely simple, usually subcylindric or slenderly fusiform, dense, to 3 dm. long. Primary bracts elliptic, acute, the lower ones short-laminate, much shorter than the spikes. Spikes erect, sessile, linear, acute, 3-10 cm. long, 1 cm. wide, complanate. Floral bracts barely to densely imbricate, broadly ovate, 15-20 mm. long, about equaling the sepals, even and glabrous or nearly so, slightly carinate toward apex. Sepals elliptic, coriaceous, glabrous, short-connate posteriorly. Petals tubular-erect, 3 cm. long, violet. Stamens and pistil exserted. BENI: CERCADO MOJOS: Trinidad, Missiones Guarayos, 250 m., *Werdermann* 2299 (MO, S). LA PAZ: SUR YUNGAS: San Bartolome, Calisaya, 750-900 m., *Krukoff* 10516 in part (MO). SANTA CRUZ: CHIQUITOS: Puerto Suarez, *Fiedrich* 8675 (AS). Mexico and the West Indies to Brazil.

54. T. **Valenzuelana** A. Rich. Fl. Cub. Fanerog. **2:** 267 (1853). Stemless, flowering 2-6 dm. high. Leaves to 4 dm. long, finely cinereous-lepidote, the sheaths concolorous with the blades, large, the blades narrowly triangular, 10-25 mm. wide, flat. Scape erect or ascending, slender, glabrous. Scape-bracts imbricate, ovate, inflated, the lower ones laminate. Inflorescence simple or pinnately compound from a few spikes. Primary bracts like the upper scape-bracts, their sheaths much shorter than the spikes but their blades sometimes exceeding them. Spikes oblong, acute, 5-20 cm. long, 1-2 cm. wide, complanate, often rather lax, 6-17-flowered, especially the terminal spike with sterile bracts at base. Floral bracts mostly 2-3 times as long as the internodes, usually exposing the rhachis, elliptic-oblong, obtuse or apiculate, 2 cm. long, much exceeding the sepals, nerved, mostly ecarinate, subglabrous. Sepals oblong, obtuse, connate posteriorly. Petals linear, 3 cm. long, lilac or violet. Stamens exserted. COCHABAMBA: AYOPAYA: Naranjito (Choco), 2200 m., *Cárdenas* 4416 (US). WITHOUT LOCALITY: *Bang* (NY). Florida and southern Mexico to Bolivia.

56. T. **paraënsis** Mez in Mart. Fl. Bras. **3**(3): 586 (1894). *T. bolivien-sis* Baker in part but not as to type. Stemless, flowering 15-46 cm. high. Leaves to 35 cm. long, minutely pale-lepidote, the outer ones reduced to small acute sheaths, the inner sheaths large and forming an ovoid pseudobulb, the blades narrowly triangular, abruptly acute, involute. Scape curved, suberect. Scape-bracts elliptic, equaling or

slightly exceeding the internodes, densely lepidote, the lower long-laminate, the upper apiculate. Inflorescence simple or of two spikes. Primary bract like the upper scape-bracts, much shorter than the axillary spike. Spikes linear, to 25 cm. long, complanate, 6-17-flowered. Floral bracts erect and imbricate but later convolute about the flowers and exposing the rhachis, broadly elliptic or suborbicular, 25-32 mm. long, ecarinate, nerved, densely lepidote. Sepals elliptic, acute, 24 mm. long, free, ecarinate, lepidote. Petals 33-70 mm. long, erect, red. Stamens exserted. LA PAZ: LARECAJA: Tuiri, Mapiri, 490-750 m., *Krukoff* 10908 (F, GH, MO, NY); SUR YUNGAS: Santa Ana, Rio Bopi, 400 m., *White* 1087 (MICH, NY); Rio Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10045; 10229 (NY). SANTA CRUZ: ICHILO: Rio Yapacani, 350 m., *Steinbach* 7596 bis (GH, NY). WITHOUT LOCALITY: *Bang* 159-A in part (K, NY). Western Brazil, Peru, Colombia.

8. **Vriesea** Lindl. nomen conservandum

See Phytologia **13:** 84 (1966).

Stemless herbs. Leaves densely rosulate, entire. Inflorescence simple or compound. Spikes usually distichous-flowered. Floral bracts conspicuous, enfolding or concealing the bases of the flowers. Sepals free. Petals nearly or quite free, bearing 2 scales on the inside at base. Ovary superior, the style elongate. Ovules many, caudate. Seeds fusiform, with a long straight basal coma.

a. Leaf-blades narrowly triangular, densely cinereous-lepidote on both sides.
   b. Floral bracts convex, ecarinate, 25-35 mm. long. ..... 1. *V. incurva.*
   b. Floral bracts carinate, 13 mm. long. ..... 2. *V. heterandra.*
a. Leaf-blades ligulate; inflorescence simple.
   c. Floral bracts dense, much exceeding the sepals, chartaceous. ..... 3. *V. heliconioides.*
   c. Floral bracts lax, about equaling the sepals, subcoriaceous. ..... 4. *V. Maxoniana.*

1. **Vriesea incurva** (Griseb.) R. W. Read in Phytologia **16:** 458. 1968. *Tillandsia incurva* Griseb. *("incurvata")* of Catalogue. Flowering 15-40 cm. long. Leaves many in a subglobose rosette, 15-35 cm. long, the sheaths large, distinct, broadly ovate to suborbicular, dark castaneous, the blades narrowly triangular, 2-3 cm. wide, cinereous. Scape slender, short. Scape-bracts barely imbricate, obovate or elliptic, densely lepidote, the lower caudate. Inflorescence pendulous, simple or digitate with 2-5 spikes. Primary bracts scarcely larger than the floral bracts. Spikes strict, linear or lance-linear with several sterile bracts at base, acute, 10-24 cm. long, strongly complanate, 7-16-flowered. Floral bracts two to three times as long as the internodes but usually exposing most of the rhachis, elliptic, obtuse, 25-35

mm. long, ecarinate at maturity, red, submembranaceous, nerved to almost even, lepidote to glabrous. Sepals free, elliptic, 15-20 mm. long, ecarinate, even, soon glabrous. Petals 35 mm. long, yellow. Stamens exserted. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 373 (US). Greater Antilles to Bolivia.

2. **V. heterandra** (E. André) L. B. Smith in Contrib. U. S. Nat. Herb. **29:** 443 (1951). Flowering to 35 cm. high. Leaves 3-4 dm. long, covered with appressed cinereous brown-centered scales, the sheaths large, dark castaneous, the blades narrowly triangular, 15-20 mm. wide. Scape curved. Scape-bracts imbricate, broadly ovate with long subsetaceous blades, densely lepidote. Inflorescence bipinnate, 15-20 cm. long. Primary bracts erect, like the scape-bracts but the upper ones merely apiculate, about equaling the sterile bases of the spikes or shorter. Spikes linear-lanceolate, acute, spreading and 4-7 cm. long above the sterile base, dense, complanate. Floral bracts ovate, acute, 13 mm. long, exceeding the sepals, lepidote. Sepals elliptic-oblong, acute, glabrous. Petals 18 mm. long, pale rose, the blades crenulate. Stamens included. LA PAZ: LARECAJA: Hacienda Casana, Tipuani, 1400 m., *Buchtien* 7184 (US). Peru to Colombia.

3. **V. heliconioides** (HBK.) Walp. Ann. Bot. **3:** 623 (1852). *V. disticha* O. Ktze. Rev. Gen. **3**(2): 304 (1898), as to material cited not as to basionym. *Guzmania obtusa* Rusby of Catalogue. Rarely flowering over 4 dm. high. Leaves about 2 dm. long, the blades ligulate, acute or attenuate, 15-30 mm. wide, subglabrous. Scape erect, usually much shorter than the leaves. Scape-bracts densely imbricate, very broadly ovate, acute. Inflorescence simple, distichous- or rarely polystichous-flowered, oblong, dense, 20 cm. long, 6 cm. wide, 6-18-flowered. Floral bracts very broadly ovate and triangular-acute or subrhombic, to 45 mm. long, chartaceous, the base suberect, the middle spreading horizontally and the apex incurved and sharply carinate, bright red above the middle, greenish yellow at the apex. Flowers suberect. Sepals lanceolate, attenuate, 27 mm. long, thin. Petals ligulate, acute, white. Stamens included. BENI: YACUMA: Rurrenabaque, *White* 1811 (NY; type of *Guzmania obtusa* Rusby); SANTA CRUZ: ICHILO: Yapacani, *Kuntze* (NY). Southwestern Brazil to Colombia and Central America.

4. **V. Maxoniana** (L. B. Smith) L. B. Smith in Phytologia, **6:** 441 (1959). *Tillandsia Maxoniana* L. B. Smith of Catalogue. *V. icterica* Castellanos of Catalogue. Flowering 2-5 dm. high. Leaves 35-55 cm. long, green and lustrous, the sheaths elliptic, large, the blades arching, ligulate, acute, 20-25 mm. wide, flat. Scape erect, slender. Scape-bracts barely imbricate, elliptic, attenuate or apiculate. Inflorescence simple, laxly few-flowered, 11-20 cm. long, strongly complanate, glabrous. Floral bracts divergent and not imbricate at anthesis, elliptic, acute, 45-55 mm. long, about equaling the sepals, carinate, incurved,

subcoriaceous, greenish yellow. Sepals narrowly elliptic, acute. Petals ligulate, flavous. Stamens exserted. LA PAZ: NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 4538 (US; type); SANTA CRUZ: FLORIDA: Samaipata, 1500 m., *Steinbach* 8221 (GH). Argentina.

9. **Guzmania** R. & P.

Stemless herbs, mostly epiphytic. Leaves entire, the sheaths usually conspicuous. Inflorescence simple or compound, the spikes always polystichous-flowered. Sepals usually somewhat connate. Petals closely agglutinated but not truly connate, naked, yellow or white. Stamens included, the filaments more or less agglutinated to the petals. Ovules many. Capsule septicidal. Seeds with a long basal straight usually brownish coma.

a. Inflorescence compound, its spikes lax to subdense but the rhachis always visible. ..... 1. *G. Roezlii.*
a. Inflorescence simple, dense, the rhachis wholly covered.
  b. Outer bracts of the inflorescence forming a cyathiform involucre that exceeds and conceals the large flowers. ..... 2. *G. lingulata.*
  b. Outer bracts of the inflorescence never concealing more than the lowest flowers.
    c. Leaf-blades obtuse to attenuate, apiculate but never retuse.
      d. Floral bracts densely brown-lepidote; sepals attenuate. ..... 3. *G. calothyrsa.*
      d. Floral bracts sparsely and obscurely lepidote; sepals broadly rounded. ..... 4. *G. Melinonii.*
    c. Leaf-blades broadly rounded and retuse. ..... 5. *G. retusa.*

1. **Guzmania Roezlii** (E. Morr.) Mez in DC. Monog. Phan. **9:** 948 (1896). Flowering 6-10 dm. high. Leaves 4 dm. long, the sheaths broadly ovate, finely brown-lepidote, concolorous or purple-striped, the blades ligulate, rounded and apiculate, 3-4 cm. wide, glabrous above. Scape erect, slender, exceeding the leaves, glabrous. Scape-bracts ovate, shorter than the internodes. Inflorescence laxly few-branched, glabrous. Primary bracts like the scape-bracts, enfolding the sterile bases of the spikes. Spikes spreading, elongate with long sterile prophyllate bases, lax or subdense but the rhachis always visible. Floral bracts ovate, narrowly obtuse, shorter than the sepals, green. Flowers suberect to spreading, 23 mm. long. Sepals elliptic, obtuse, 16-18 mm. long, connate for 2 mm., coriaceous. Corolla white, its lobes recurved-spreading. LA PAZ: LARECAJA: San Carlos, Mapiri, 650 m., *Buchtien* 1272 (US); SUR YUNGAS: Rio Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10516 (GH, MO, NY). Peru to Costa Rica and Guiana.

2. **G. lingulata** (L.) Mez in DC. Monog. Phan. **9:** 899 (1896). Rather variable in habit, flowering about 3 dm. high. Leaves 30-45 cm. long, the sheaths ovate, conspicuous, sometimes violet-striped, the blades

ligulate, acute, obscurely punctulate-lepidote. Scape-bracts densely imbricate, the lower ones strict, foliaceous, the uppermost lanceolate, usually red, forming a more or less spreading involucre. Inflorescence to 7 cm. wide, 10-50-flowered. Floral bracts linear, shorter than the flowers. Flowers erect, 45 mm. long. Sepals linear, obtuse, glabrous. Petals linear, cucullate, white at the apex. Stamens highly agglutinated with the petals. Coma reddish brown. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 366 (GH, US); NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 3670 (US); 3673 (NY, US). Southwestern Brazil to Central America and the West Indies.

3. **G. calothyrsa** Mez in DC. Monog. Phan. **9:** 910 (1896). Flowering to 1 m. high. Leaves 3-8 dm. long, densely punctulate-lepidote beneath, the blades linear, attenuate, 2-4 cm. broad. Scape stout, erect. Scape-bracts densely imbricate, lanceolate, attenuate, ferruginous-lepidote. Inflorescence strobilate, fertile throughout, 6-18 cm. long. Floral bracts broadly elliptic, acute, membranaceous, densely brown-lepidote. Sepals narrowly elliptic, attenuate, 22 mm. long, connate for 6 mm., thin, lepidote becoming glabrous. Petals obtuse. LA PAZ: LARECAJA: San Carlos, Mapiri, 750 m., *Buchtien* 1265 (US); SUR YUNGAS: Rio Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10488 (GH, NY). Peru, Colombia.

4. **G. Melinonis** Regel in Gartenfl. **34:** 116 (1885). Flowering 20-23 cm. high. Leaves 3-5 dm. long, the blades ligulate, broadly acute or obtuse and apiculate, 2-4 cm. wide, soon glabrous. Scape straight, glabrous. Scape-bracts imbricate, strict, broadly ovate, acute, red. Inflorescence ellipsoid or subcylindric, 5-10 cm. long. Floral bracts about 4-ranked, broadly ovate, nearly equaling the flowers, sparsely and obscurely lepidote, nerved, bright red. Flowers to 33 mm. long. Sepals broadly elliptic, obtuse, 15 mm. long, short-connate, firm, even, glabrous. Petals obtuse, yellow or white. Coma white. LA PAZ: LARECAJA: Mapiri, 3000 m., *Bang* 1582 (GH). COCHABAMBA: CHAPARE: Antahuacana, Espíritu Santo, 750 m., *Buchtien* 4539 (US); Puerto Polonia, Rio Coni, San Antonio, 395 m., *Cárdenas & Cutler* 7362 (GH). Ecuador, Colombia, French Guiana.

5. **G. retusa** L. B. Smith in Fieldiana Bot. **28: 143** (1951). Leaves 5 dm. long, exceeding the inflorescence, minutely and obscurely lepidote, the blades ligulate, broadly rounded and retuse, 6 cm. wide. Scape erect, slender. Scape-bracts densely imbricate, elliptic, apiculate. Inflorescence simple, densely ellipsoid, 4.5 cm. long, 2 cm. wide, fertile throughout. Floral bracts orbicular, 2 cm. long, exceeding the sepals, coriaceous, lustrous, punctulate-lepidote, nerved or nearly even. Sepals elliptic, 13 mm. long, equally connate for 5 mm., carinate, coriaceous, sparsely lepidote at apex. Petals 23 mm. long, the free lobes broadly elliptic. Stamens included. COCHABAMBA: CHAPARE: Locotal, 1600 m., *Steinbach* 9623 (GH, US). Colombia, Venezuela.

10. **Streptocalyx** Beer

Stemless herbs. Leaves spinose-serrate. Scape elongate to almost none. Inflorescence central, bipinnate, dense. Flowers sessile. Sepals free or nearly so, asymmetric with a broad lateral wing. Petals free, narrow, naked. Stamens and pistil included. Pollen grains with 2 or 4 pores. Ovary farinose, the epigynous tube distinct. Fruit somewhat fleshy. Seeds ellipsoid or ovoid, naked.

Floral bracts ovate, about equaling the ovary; scape very short and hidden in the center of the rosette. ..... 1. *S. Fuerstenbergii.*
Floral bracts reniform, much shorter than the ovary; scape evident. ..... 2. *S. Poeppigii.*

1. **Streptocalyx Fuerstenbergii** (E. Morr. & Wittm.) E. Morr. in Belg. Hortic. **33:** 16 (1883). Leaves 50-75 cm. long, the sheaths large, elliptic, covered with a brown membrane of fused scales, the blades ligulate, attenuate to a pungent apex, 2 cm. wide, laxly serrate with curved spines, sparsely lepidote. Scape short, stout. Scape-bracts densely imbricate, broadly ovate with narrowly triangular pungent blades, densely fimbriate-serrate, bright rose, pale-lepidote. Inflorescence bipinnate, very dense, slenderly pyramidal, 3 dm. long, 1 dm. wide, white-farinose except the petals. Primary bracts like the scape-bracts but bladeless, apiculate, erect, slightly exceeding the spikes. Spikes 6 cm. long, sublax, to 9-flowered. Floral bracts ovate, attenuate, about equaling the ovary, entire. Flowers distichous, divergent. Sepals free or nearly so, 15 mm. long exclusive of the terminal spine, 7-8 mm. wide, entire. Ovary ellipsoid, 8 mm. long, enlarged in fruit, the epigynous tube urceolate. BENI: YACUMA: Reyes, Rurrenabaque, *Fleischmann* 66 (S). Brazil.

2. S. **Poeppigii** Beer, Bromel. 141 (1857). Flowering 5-8 dm. high. Leaves to 16 dm. long, the sheaths elliptic, ample, dark castaneous, densely buff-lepidote, the blades linear, attenuate to a dark pungent cusp, 3-7 cm. wide, laxly serrate with dark curved spines 1-4 mm. long, densely white-lepidote beneath, soon glabrous above. Scape curved, red. Scape-bracts imbricate, broadly ovate with a linear blade, fimbriate-serrate, bright rose. Inflorescence densely bipinnate, slenderly cylindric or pyramidal, 2-4 dm. long, 9-15 cm. in diameter, white-farinose. Primary bracts like the scape-bracts but merely apiculate, about equaling the spikes, divergent. Spikes 5-7 cm. long, laxly 2-10-flowered. Floral bracts reniform, mucronulate, much shorter than the ovary. Sepals free, strongly asymmetric, 16-19 mm. long, mucronate. Petals bright purple. Ovary cylindric, the epigynous tube large, the placentae apical. LA PAZ: LARECAJA: Sarampiuni, San Carlos, Mapiri, 500 m., *Buchtien* 370 (US). Brazil, Peru, Colombia, Surinam.

11. **Bromelia** L.

Coarse terrestrial herbs, spreading by rhizomes or offsets. Leaves rosulate, bearing large curved spines along the margins. Inflorescence

scapose, always compound. Sepals free, unarmed. Petals without a definite claw, united into a tube by the filaments but their margins free, without appendages, fleshy. Stamens included, their filaments forming a tube of varying lengths according to the species. Berry succulent, relatively large. Seeds flattened, naked.

a. Inflorescence very laxly paniculate, the branches to 18 cm. long. .... 1. *B. Hieronymii.*
a. Inflorescence dense, the branches less than 5 cm. long.
  b. Inflorescence cylindric, to 22 cm. long; sepals becoming glabrous. ..... 2. *B. Balansae.*
  b. Inflorescence globose, 6 cm. in diameter; sepals densely and persistently lepidote. ..... 3. *B. serra.*

1. **Bromelia Hieronymii** Mez in Mart. Fl. Bras. 3(3): 199 (1891). Flowering 1 m. high, propagating by very stout rhizomes. Leaves 7 dm. long, the sheaths small, thick and forming a subglobose bulb, covered with a membrane of fused scales, the blades 30 mm. wide, mostly glabrous above, very closely pale-lepidote beneath. Scape rather slender. Scape-bracts subfoliaceous, exceeding the internodes. Inflorescence very laxly paniculate, glabrous, glaucous. Primary bracts subfoliaceous but small and much shorter than the branches. Branches suberect to spreading, 12-18 cm. long, 7-13-flowered. Floral bracts triangular, 5-6 mm. long. Pedicels rather slender, 5-11 mm. long. Sepals free, ovate, obtuse, entire, 7 mm. long. Petals 15 mm. long, connate for 7 mm., lilac. Ovary ellipsoid, 20 mm. long. SANTA CRUZ: CORDILLERA: Oriente, Izogzog, 700 m., *Cárdenas* 2755 (GH). Paraguay, Argentina.

2. **B. Balansae** Mez in Mart. Fl. Bras. 3(3): 191 (1891). Flowering to over 1 m. high, propagating by stolons. Leaves over 1 m. long, the blades attenuate, 25 mm. wide, glabrous above, closely pale-lepidote beneath, laxly serrate with antrorse spines. Scape erect, stout. Scape-bracts like the inner leaves, imbricate. Inflorescence densely cylindric, 18-22 cm. long, 7-9 cm. in diameter, the axes densely white-lanuginose. Primary bracts large covering most of the flowers. Branches to 10-flowered. Floral bracts narrowly elliptic, 30 mm. long, equaling the centers of the sepals, subglabrous. Flowers subsessile, to 45 mm. long. Sepals elliptic, obtuse, to 20 mm. long, coriaceous, allutaceous, soon glabrous. Petals linear, obtuse, 25 mm. long, connate for 7-8 mm., deep violet with broad white margins, glabrous. Filaments more than 1/2 connate. Ovary clavate, trigonous. Fruit to 47 mm. long, fleshy, edible. Seeds many, flat, 5 mm. wide. BENI: PROVINCE [?]: Rio Guaporé, Santo Antonio de Manoelito, *Black & Cordeiro* 52-15327 (IAN). Brazil, Paraguay, Argentina.

3. **B. serra** Griseb. in Goett. Abh. **24:** 328 (1879). Flowering to 4 dm. high, propagating by long scaly stolons. Leaves 1.5 m. long, the

blades attenuate, 4 cm. wide, laxly serrate with antrorse uncinate spines 5 mm. long, lepidote, green above, cinereous beneath. Scape short, stout, densely lepidote. Scape-bracts foliaceous, densely imbricate, bright red. Inflorescence densely globose, 6 cm. in diameter. Primary bracts broadly ovate, 4 cm. long, covering most of the fasciculate flowers. Branches short, 5-9-flowered. Floral bracts ligulate, obtuse, cucullate, 30 mm. long, carinate, densely pale-lepidote. Pedicels 5-10 mm. long in fruit. Sepals oblong, cucullate, 15 mm. long, strongly carinate, white, lepidote. Petals elliptic, obtuse, connate for 5 mm. blue-purple with white base and margins. Filament-tube 3 mm. high. Ovary subcylindric, angled, 2 cm. long. Fruit ovoid, 40 mm. long. BENI: CERCADO MOJOS: Trinidad, Missiones Guarayos, 250 m., *Werdermann* 2300 (S). SANTA CRUZ: VELASCO: 200 m., *Kuntze* (NY); CORDILLERA: Oriente, Izogzog, 700 m., *Cárdenas* 2756 (GH). Paraguay, Argentina.

12. **Aechmea** R. & P.

Large or medium-sized herbs. Leaves rosulate. Scape conspicuous. Inflorescence simple or compound, very variable. Flowers sessile. Sepals mostly asymmetric with a large wing on the right. Petals free, bearing 2 scales. Second series of stamens more or less joined to the petals, the pollen grains with 2 or 4 pores. Ovules caudate or obtuse. Berry usually dry. Seeds small, rugose, dark.

a. Inflorescence compound.
  b. Floral bracts neither decurrent nor forming pouches about the flowers.
    c. Floral bracts forming a sheath that completely encloses the base of the ovary; inflorescence densely ferruginous-lepidote. ..... 1. *Ae. Kuntzeana.*
    c. Floral bracts not completely enclosing the base of the ovary, their margins failing to meet.
      d. Floral bracts equaling or exceeding the ovaries, navicular.
        e. Spike-rhachis excavated. ..... 2. *Ae. angustifolia.*
        e. Spike-rhachis merely angled. ..... 3. *Ae. brachyclada.*
      d. Floral bracts distinctly shorter than the ovaries.
        f. Upper scape-bracts reflexed, massed beneath the inflorescence, serrate. ..... 4. *Ae. Castelnavii.*
        f. Upper scape-bracts suberect, entire. .... 5. *Ae. tocantina.*
  b. Floral bracts decurrent and forming pouches around the flowers. ..... 6. *Ae. distichantha.*
a. Inflorescence simple, strobilate, densely white-lanate; sepals unarmed. ..... 7. *Ae. bromeliifolia.*

1. **Aechmea Kuntzeana** Mez in DC. Monog. Phan. **9:** 208 (1896). Leaf-blades ligulate, subrounded and terminating in a stout dark spine, nearly 9 cm. wide, serrate with black antrorse spines, densely lepidote beneath. Scape erect, stout, ferruginous-tomentose. Upper

scape-bracts reflexed, elliptic, serrate with dark spines. Inflorescence bipinnate, subdensely cylindric, 20 cm. long, 5 cm. wide, ferruginous-lepidote. Branches suberect to spreading, 2-flowered, very short, all fertile but especially the highest with the terminal bracts changed to elongate spines with pulvinate bases. Floral bracts strongly asymmetric, much wider than long, bearing a dark suberect spine 21 mm. long, enfolding the ovary, entire, the margins free from the rhachis. Flowers 25 mm. long without the petals. Sepals strongly asymmetric, free, minutely mucronate. Ovary 6 mm. long. BENI: CERCADO MOJOS: Trinidad, Missiones Guarayos, 250 m., *Werdermann* 2420 (MO); YACUMA: Rurrenabaque, 300 m., *Rusby* (Mulford Exped.) 1252 (NY). SANTA CRUZ: ICHILO: Yapacani, 400 m., *Kuntze* (NY; type).

2. **Ae. angustifolia** Poepp. & Endl. Nov. Gen. & Spec. 2: 43, t. 159 (1838). *Ae. boliviana* Rusby of Catalogue. *Ae. inconspicua* Harms of Catalogue. Flowering to 75 cm. high. Leaves 5-7 dm. long, the sheaths 1 dm. long, forming an ellipsoid tank, densely and finely brown-lepidote, the blades ligulate, 3-6 cm. wide, cinereous-lepidote, spinose-serrate, concolorous. Scape erect, becoming glabrous. Scape-bracts elliptic, acute, serrate, red. Inflorescence bipinnate, cylindric, dense or lax, fertile throughout, 15-36 cm. long. Lowest primary bracts like the scape-bracts, exceeding the spikes, the others abruptly reduced to about the size of the floral bracts. Spikes spreading or reflexed, distichously 10-flowered, 20-55 mm. long, the rhachis undulate, excavated. Floral bracts spreading, cymbiform, broadly ovate with a straight mucro, 5 mm. long, barely exceeding the ovary. Sepals asymmetric, mucronate, 4-5 mm. long, free. Petals linear, mucronate, 8-10 mm. long. Ovary ellipsoid, the placentae apical, the ovules caudate. LA PAZ: LARECAJA: Mapiri, San Carlos, 850 m., *Buchtien* 368 (B; type of *Ae. inconspicua* Harms; NY); 374 (US); 750 m., *Buchtien* 1264 (US); NOR YUNGAS: Polo-Polo, Coroico, 1100 m., *Buchtien* 4537 (US); SUR YUNGAS: Río Bopi Basin, San Bartolome, Calisaya, 750-900 m., *Krukoff* 10510 (NY); *Krukoff* 10511 (GH, NY); LARECAJA: Copacabana, Mapiri, 850-950 m., *Krukoff* 11368 (NY); CAUPOLICÁN: Tumupasa, 540 m., *Williams* 525 (NY). WITHOUT LOCALITY: *Bang* s. n. (NY; type of *Ae. boliviana* Rusby).

3. **Ae. brachyclada** Baker, Handbk. Bromel. 37 (1889). Flowering 6 dm. high. Leaves 4 dm. long, the sheaths ovate-elliptic, forming a large ventricose tank, the blades erect, ligulate, attenuate, 30 mm. wide, densely serrate with spreading or recurving spines 5 mm. long, densely pale-lepidote. Scape erect, slender, about equaling the leaves, densely white-tomentellous. Scape-bracts lanceolate, acute, entire, erect, especially the lower ones shorter than the internodes. Inflorescence bipinnate throughout, wholly fertile, cylindric, 20 cm. long, densely tomentellous. Upper primary bracts greatly reduced. Branches spreading, less than 2 cm. long. Floral bracts spreading, spinose-

attenuate from a broadly ovate base, navicular, to 6 mm. long, scarcely if at all adnate to the rhachis. Flowers to 16 mm. long. Sepals strongly asymmetric, mucronate, to 4 mm. long, subfree. Petals acute. Ovary ellipsoid, to 4 mm. long, the epigynous tube distinct, urceolate, the placentae apical, the ovules long-caudate. SANTA CRUZ: Chiquitos: *Weddell* s. n. (P; type).

4. **Ae. Castelnavii** Baker, Handbk. Bromel. 39 (1889). *Ae. Sprucei* Mez in DC. Monog. Phan. **9**: 226 (1896). Leaves unknown. Scape straight, stout, ferruginous-furfuraceous toward apex. Scape-bracts reflexed, narrowly ovate, attenuate to a pungent spine, to 20 cm. long, 45 mm. wide, densely serrate with spreading teeth, bright purple, membranaceous. Inflorescence tripinnate, densely subcylindric, 40 cm. long, 75 mm. wide, densely furfuraceous. Lower primary bracts like the scape-bracts, the others greatly reduced. Branches spreading, wholly fertile, divided to apex, about 5-flowered. Floral bracts chiefly spinose from an elliptic base, to 5 mm. long. Flowers to 17 mm. long. Sepals strongly asymmetric, 6 mm. long with a 3 mm. terminal spine, nearly free. Petals rounded, reddish when dry. Stamens included. Ovary slenderly ellipsoid, 8 mm. long, the epigynous tube very short, the placentae apical, the ovules caudate. SANTA CRUZ: PROVINCE [?]: *Castelnau* s. n. (P; type). Brazil, Venezuela, Colombia, Costa Rica.

5. **Ae. tocantina** Baker, Handbk. Bromel. 39 (1889). Flowering 1-2 m. high. Leaves to over 1 m. long, the sheaths broadly elliptic, large, the blades ligulate, subacute and attenuate to a stout spine, 4-10 cm. wide, repand-serrate with straight or slightly curved flat brown spines, glabrous above, covered beneath with minute pale-ferruginous scales. Scape erect, ferruginous-furfuraceous. Scape-bracts imbricate, lance-elliptic, acute, pungent, entire, especially the lower ferruginous-lepidote. Inflorescence subdensely cylindric, bipinnate or at base tripinnate, 17-33 cm. long, 7-8 cm. wide, ferruginous-tomentulose. Lower primary bracts like the scape-bracts, exceeding the branches, the others much smaller, the highest subfiliform, very short. Spikes spreading, laxly 4-8-flowered, to 4 cm. long, wholly fertile, the rhachis nearly straight. Floral bracts distichous, spreading, ovate, mucronate, entire, 5 mm. long, usually shorter than the ovary, nerved, the margins free from the rhachis. Flowers 15 mm. long. Sepals strongly asymmetric, short-mucronate, 5 mm. long, short-connate. Petal-scales fimbriate. Ovary ellipsoid, the epigynous tube short but distinct, the placentae apical, the ovules caudate. BENI: CERCADO MOJOS: Trinidad, Missiones Guarayos, 250 m., *Werdermann* 2464 (MO, S). SANTA CRUZ: CERCADO: El Palmar, 500 m., *Cárdenas* 4649 (US); VALLEGRANDE: Los Monos, *I. S. Nelson* G-228 (US). Brazil, Venezuela, Surinam.

6. **Ae. distichantha** Lem. in Jard. Fleur. **3**: t. 269 (1853). Flowering 3-7 dm. high. Leaves 3-10 (-15) dm. long, covered on both sides with a membrane of pale fused scales, the sheaths elliptic or oblong, to

3 dm. long, usually much wider than the blades, the blades ligulate, typically with a broad apex, pungent, 25-80 mm. wide, finely to coarsely serrate. Scape erect, white-flocculose. Scape-bracts densely imbricate, elliptic, attenuate, rose, mostly entire. Inflorescence bipinnate, typically lax or sublax and broadly pyramidal, rose and white-flocculose except the petals. Primary bracts broadly ovate, apiculate, often shorter than the spikes. Spikes subsessile, typically spreading and dense, the lateral ones with 2-12 distichous flowers, the terminal with more and polystichous flowers. Floral bracts pouch-shaped, entire, truncate, mucronulate, about equaling the ovary, thin, nerved. Flowers suberect, 15-29 mm. long. Sepals asymmetric, oblong or subquadrate, mucronulate, 5-13 mm. long, free or short-connate. Petals obtuse, purple or blue, the scales serrate. Stamens included. Ovary short-cylindric or obconic, 4-6 mm. long, the epigynous tube large, crateriform, the placentae subcentral, the ovules acute or obtuse. Not reported from Bolivia. Brazil, Argentina, Paraguay.

6a. **Ae. distichantha** var. **Schlumbergeri** E. Morr. ex Mez in Mart. Fl. Bras. **3**(3): 343 (1892). *Ae. involucrata* Rusby of Catalogue. *Ae. involucrifera* Mez of Catalogue. Leaves usually attenuate. Inflorescence dense, elongate, slenderly cylindric or fusiform. Spikes erect, few-flowered. LA PAZ: SUR YUNGAS: Irupana, 1800 m., *Cárdenas* 4378 (US). COCHABAMBA: *Province* [?]: Monte Punco, *Cárdenas* 5588 (US). SANTA CRUZ: VELASCO: 200 m., *Kuntze* s. n. (NY); VALLE GRANDE: Samaipata, 1800 m., *Cárdenas* 3520 (GH); CHIQUITOS: *Weddell* 3512 (P); Santiago de Chiquitos, 700 m., *Cutler* 7026 (GH). WITHOUT LOCALITY: *Bang* s. n. (NY; type of *Ae. involucrata* Rusby and *Ae. involucrifera* Mez). Brazil, Paraguay, Argentina.

7. **Ae. bromeliifolia** (Rudge) Baker ex Benth. & Hook. f. Gen. Pl. **3**: 664 (1883). *Ae. ellipsoidea* Rusby of Catalogue. Flowering 7-9 dm. high. Leaves 12-20 in a tubular rosette, 6-12 dm. long, covered on both sides with a membrane of white fused scales, the sheaths ovate to elliptic-oblong, 1-3 dm. long, the blades ligulate, very variable, attenuate to rounded and apiculate, 4-9 cm. wide, concolorous, laxly serrate with spines to 10 mm. long. Scape erect, stout, densely white-lanate. Scape-bracts lance-ovate, acute, entire, thin, the upper ones densely imbricate. Inflorescence densely spicate, ellipsoid or cylindric, fertile throughout, to 15 cm. long, 3-4 cm. wide, densely white-lanate with only the petals exposed at first. Floral bracts broader than long, truncate, thick, coriaceous, bicarinate, enfolding the ovary, much shorter than the sepals. Sepals suborbicular, emarginate, 7 mm. long, equally short-connate. Petals oblong, emarginate, 15 mm. long, greenish yellow, soon turning black, the scales fimbriate. Ovary tomentose, the placentae apical, the ovules long-caudate. LA PAZ: SUR YUNGAS: basin of Río Bopi, San Bartolomé, Calisaya, 750-900 m., *Krukoff*

10248 (GH, NY); Asunto, 840 m., *White* 633 (NY; type of *Ae. ellipsoidea* Rusby). SANTA CRUZ: CHIQUITOS: Santiago, 640 m., *Cutler* 7035 (GH). Argentina to Central America.

13. **Billbergia** Thunb.

Stemless herbs. Leaves rosulate or fasciculate, the sheaths large, the blades ligulate. Scape erect or arching. Scape-bracts ample, thin. Inflorescence simple, spicate. Sepals unarmed. Petals free, spirally recurved at anthesis (subgenus *Helicodea*), bearing 2 scales at base, the claw elongate, the blade narrow. Stamens exserted at anthesis, free from the petals or nearly so, the pollen grains with longitudinal folds when dry but no pores. Epigynous tube evident, the ovules many.

a. Sepals narrow, 15-24 mm. long.
  b. Floral bracts shorter than the ovary; sepals 20-24 mm. long. .... 1. *B. microlepis.*
  b. Floral bracts exceeding the ovary and the lowest exceeding the sepals; sepals 15-20 mm. long. ..... 2. *B. Meyeri.*
a. Sepals broad, 10-12 mm. long; floral bracts shorter than the ovary.
  c. Ovary slightly or not at all sulcate, wholly white-farinose; floral bracts minute or wanting; petals green. .... 3. *B. decora.*
  c. Ovary sulcate with the ridges usually glabrous and dark; floral bracts evident.
    d. Petals clear yellow throughout. ..... 4. *B. Cardenasii.*
    d. Petals blue. ..... 5. *B. velascana.*

1. **Billbergia microlepis** L. B. Smith in Phytologia **8:** 504, t. 3, figs. 3, 4 (1963). Leaves 50-75 cm. long, densely appressed-lepidote on both sides, white-banded beneath; the blades ligulate, subacute, apiculate, 5-7 cm. wide, laxly serrate with flat black spreading teeth 1.5-5 mm. long. Scape slender, decurved, finely pale-lepidote. Scape-bracts elliptic, acute, 13 cm. long. Inflorescence lax, 15 cm. long, the rhachis densely pale-lepidote. Floral bracts broadly ovate, apiculate, the lowest almost equaling the ovary, the others much shorter. Flowers sessile. Sepals subequal, lance-oblong, attenuate, 20-24 mm. long, soon glabrous except at base. Petals over 14 cm. long, greenish when dry. Ovary ellipsoid, sulcate with dark lines against the white indument, 9 mm. high exclusive of the 3 mm. short-cylindric epigynous tube. LA PAZ: LARECAJA: Copacabana, Mapiri, 850-950 m., *Krukoff* 11158 (GH; type).

2. **B. Meyeri** Mez in Engler, Bot. Jahrb. **30:** 148 (1902). Leaves few in a long tubular rosette, 40-75 cm. long, pale-lepidote and white-banded beneath, the sheaths very large, narrowly elliptic, the blades acute, 35 mm. wide, sublaxly serrate with antrorse curved spines 1-2 mm. long. Scape decurved, slender, white-farinose. Scape-bracts large, lanceolate, attenuate, the lower erect and about equaling the

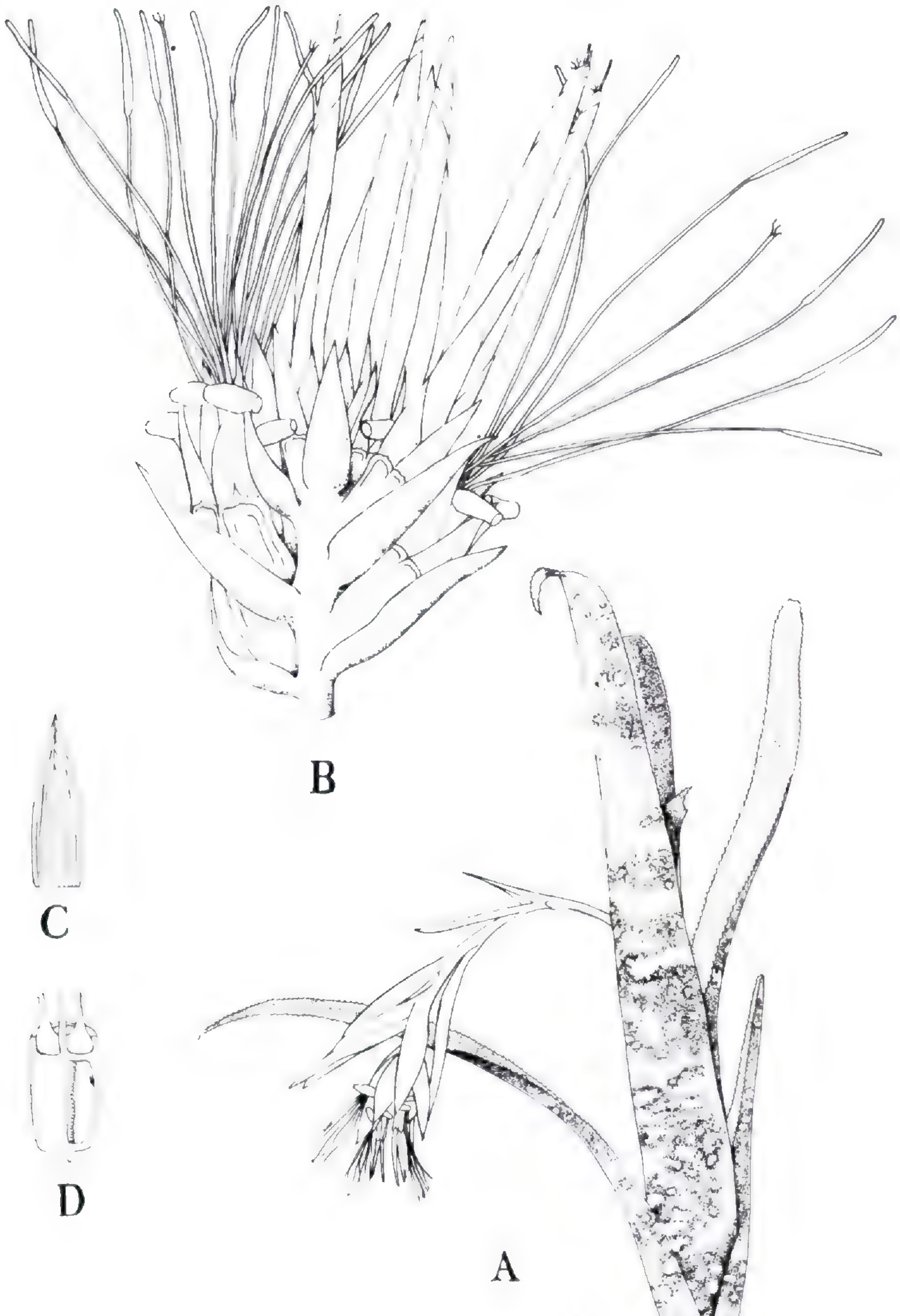

Figure 3.
A: *Billbergia Meyeri* (after *I. S. Nelson* G-35), habit from photo; B: inflorescence × 1; C: sepal × 1; D: section of ovary × 1.

internodes, the upper divergent and massed beneath the inflorescence. Inflorescence sublax, 7-11 cm. long, densely white-farinose except for the petals, the rhachis straight. Floral bracts large, at least exceeding the ovary and the lowest ample and exceeding the sepals, ovate, acute, violet. Flowers divergent. Sepals free, equal, triangular, attenuate, 15-20 mm. long. Petals 45-50 mm. long, green or greenish white, the scales coarsely crenate. Ovary ellipsoid, the epigynous tube 4-5 mm. deep. SANTA CRUZ: CERCADO: Hacienda Sauce, Santa Cruz, *I. S. Nelson* G-35 (US). Brazil. Fig. 3.

3. **B. decora** Poepp. & Endl. Nov. Gen. & Spec. **2:** 42, t. 157 (1838). *B. boliviensis* Baker, Handbk. Bromel. 81 (1889). Leaves few in a tubular or narrowly funnelform rosette, to 7 dm. long, white-banded beneath and sometimes yellow-spotted as well. Blades broadly acute or subrounded and apiculate, to 6 cm. wide, sublaxly serrate with stout antrorse spines. Scape decurved, more or less white-farinose. Scape-bracts lanceolate or elliptic, acute, entire, bright rose, the upper ones massed beneath the inflorescence. Inflorescence sublax, 10-15 cm. long, densely white-farinose except the petals. Floral bracts minute or lacking. Flowers 9-10 cm. long. Sepals suboblong or broadly ovate, broadly acute and apiculate, to 12 mm. long. Petals wholly green. Ovary ellipsoid, scarcely or not at all sulcate, without spots or dark glabrous lines, the epigynous tube short. LA PAZ: NOR YUNGAS: Unduavi, 2400 m., *Rusby* 2853 (NY; type of *B. boliviensis* Baker). Brazil, Peru.

4. **B. Cardenasii** L. B. Smith in Phytologia, 4(6): 382 (1953). Leaf-blades broadly acute and apiculate, 4 dm. long, 35 mm. wide, covered on both sides with coarse cinereous appressed scales, laxly serrate with dark curved teeth 2 mm. long. Scape slender, densely and very finely white-flocculose. Scape-bracts lanceolate, acute, 13 cm. long, rose. Inflorescence densely many-flowered, the axis white-flocculose. Floral bracts ovate, acute, shorter than the ovary, membranaceous, glabrous except the base. Sepals equal, ovate, broadly acute, 10 mm. long, thin, nerved, orange, nearly glabrous. Petals 5 cm. long, yellow, the scales denticulate. Ovary ellipsoid, strongly trigonous, 10 mm. long, sulcate, white-flocculose, the epigynous tube small and narrow. COCHABAMBA: CHAPARE: cultivated, probably from Yungas del Chapare, *Cárdenas* 4907 (US; type).

5. **B. velascana** Cárdenas in Bromel. Soc. Bull. **7:** 35 (1957). Flowering 6 dm. high. Leaf-blades abruptly acute, 6 dm. long, 2-5 cm. wide, spinulose, gray-green, white-banded. Scape 4 dm. long, 8 mm. thick, densely flocculose. Scape-bracts lanceolate, 16-19 cm. long, rose. Inflorescence many-flowered, the rhachis straight, white-flocculose. Floral bracts ovate, acute, 8 mm. long, membranaceous, rose. Flowers 6-8 cm. long. Sepals lance-ovate, acute, 12 mm. long, green toward base,

violet toward apex, flocculose. Petals 5 cm. long, 6 mm. wide, blue. Ovary ovoid-conical, 12 mm. long, trigonous, sulcate, white-flocculose. SANTA CRUZ: VELASCO: San Ignacio, 500 m., *Hammerschmidt* 5486 in hb. Cárdenas (type).

14. **Pseudananas** Hassler ex Harms

Pseudananas sagenarius (Arruda) Camargo in Rev. Agric. Piracicaba, **14** (7, 8): reprint p. 4 (1939). Caulescent, flowering 1 m. high, propagating by long basal stolons. Stem leafy, straight, 30 cm. high, 5 cm. in diameter. Leaves 30-40, arching, to 12 dm. long, the blades linear, 6-7 cm. wide, deeply channeled, coriaceous, reddish green and lustrous above, densely lepidote beneath, laxly serrate with curved antrorse and retrorse spines 10 mm. long. Scape erect, stout, 2-3 dm. high, furfuraceous. Scape-bracts foliaceous, reduced, reddish. Inflorescence simple, strobilate, ovoid with the apical coma inconspicuous or lacking, 17 cm. long, 9 cm. in diameter, 150-200-flowered. Floral bracts densely imbricate, lanceolate, attenuate, nearly equaling the petals, serrulate, red, cinereous-lepidote, persistent. Flowers connate by their ovaries and forming a syncarp. Sepals asymmetric, ovate, apiculate, 10-13 mm. long, conduplicate or merely channeled, thick with membranous margins, red orange, sparsely lepidote. Petals 4-5 cm. long, the blade lanceolate, purple, the claw bearing lateral folds that overlap the filaments. Stamens included. Syncarp 20 cm. long, succulent. SANTA CRUZ: CHIQUITOS: Puerto Sucre, near Brazilian frontier, *Baker & Collins* s. n. (GH). Brazil, Paraguay.

15. **Ananas** Mill.

Not producing stolons. Leaves densely rosulate, scarcely enlarged at base. Scape evident, erect. Inflorescence densely strobilate, crowned with a tuft of sterile foliaceous bracts, often producing slips at the base. Flowers sessile. Sepals free, obtuse, slightly asymmetric. Petals free, erect, violet or red, each bearing 2 slenderly funnelform scales. Stamens included. Ovaries coalescing with each other and with the bracts and axis to form a fleshy syncarp, the epigynous tube short, the placentae apical, the ovules caudate.

Syncarp 15 cm. long or usually much less, with scant unpalatable flesh at maturity; scape elongate, slender; seeds numerous. ..... 1. *A. ananassoides.*

Syncarp well over 15 cm. long at maturity with copious palatable flesh; scape stout and usually short; seeds lacking or very rare. ..... 2. *A. comosus.*

1. **Ananas ananassoides** (Baker) L. B. Smith in Bot. Mus. Leafl. Harvard Univ. **7:** 79 (1939). Flowering over 1 m. high. Leaves many, more than 16 dm. long, the sheaths densely ferruginous-lepidote, the blades linear, long-attenuate, rarely over 35 mm. wide, subdensely serrate with antrorse spines, green, minutely white-lepidote. Scape

slender, soon glabrous. Scape-bracts large, subfoliaceous. Inflorescence subcylindric, the apical coma small at anthesis but becoming greatly enlarged. Floral bracts broadly elliptic, attenuate, 15-20 mm. long, exceeding the sepals, pungent, serrulate. Sepals broadly elliptic, 7 mm. long. Petals 13-17 mm. long. Fruit slightly enlarged after anthesis, scarcely edible, readily breaking from the scape. Seeds numerous. SANTA CRUZ: CHIQUITOS: Robore, Oriente, 250 m., *Cárdenas* 2929 (GH). Paraguay, Brazil, Venezuela, Colombia.

2. **A. comosus** (L.) Merrill, Interpr. Rumph. Amboin. 133 (1917). Leaves coarsely and laxly spinose-serrate. Scape short, stout. Scape-bracts foliaceous, serrate. Inflorescence large, many-flowered. Floral bracts soon exposing the apices of the ovaries, relatively inconspicuous, weakly serrulate or entire. Syncarp well over 15 cm. long at maturity with copious palatable flesh. Seeds lacking or very rare. Tropical lowlands in cultivation but no herbarium specimens. See Encyclopedia Britannica, ed. 14, 3: 815 (1929).

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CHROMOSOME COUNTS OF KALMIA SPECIES AND REVALUATION OF K. POLIFOLIA VAR. MICROPHYLLA

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Kalmia L. is a small North American genus of woody shrubs belonging to the Ericaceae. There are 7-10 species in the genus depending on the authority. Two taxa, *K. polifolia* var. *polifolia* Wangenh.[1] and *K. p.* var. *microphylla* (Hook.) Rehd. are morphologically very similar and thus have often been placed in the same species. Although these two taxa can be readily crossed (Jaynes 1968), other evidence obtained in the course of genetic studies suggests that var. *microphylla* should be treated as a separate species *(K. microphylla)* as originally done by Heller (1898). In this paper their taxonomic status is considered in the light of cytological and other evidence. Chromosome counts of four other species of *Kalmia* are also reported for the first time.

Previously, Hagerup (1928) reported $n = 12$ for *Kalmia latifolia* and $n = 24$ for *K. polifolia* (as *K. glauca*), counts which are verified by this report. Callan (1941), however, reported $2n = 44$ for *K. polifolia*, which appears to be incorrect.

The counts given here were made during meiosis, usually at metaphase I, on pollen mother cells using an aceto-carmine smear technique. Buds were fixed in ethyl alcohol (95%) and glacial acetic acid (3:1) for at least 24 hours, then rinsed and stored in 70% ethyl alcohol at 4C. Stained preparations were photographed under phase contrast.

The list of species with geographic sources and the counts obtained are presented in Table 1. One or two plants per source were used and a minimum of four figures were ex-

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[1]Synonym *K. p.* var. *rosmarinifolia* (Pursh) Rehd. There is apparently no evidence to substantiate the existence of a var. *rosmarinifolia* as well as a var. *polifolia* (Wood 1961) as is suggested by the use of the name *K. p.* var. *rosmarinifolia.*

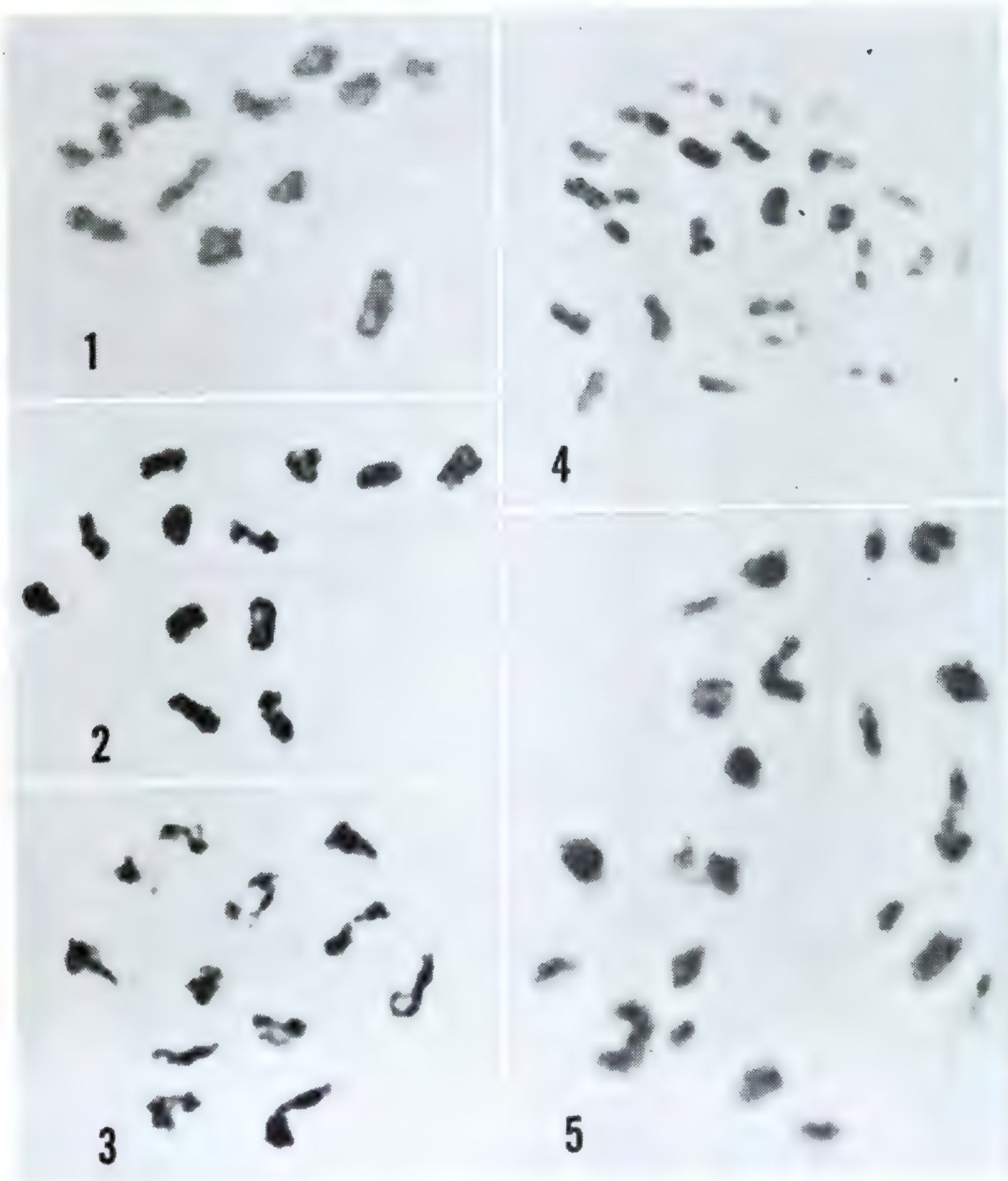

Plate 1414.

Figs. 1-5. Chromosomes of *Kalmia* species, MI, sources in parenthesis. Fig. 1. *K. cuneata* (North Carolina) $n = 12$. Fig. 2. *K. hirsuta* (Alabama) $n = 12$. Fig. 3. *K. microphylla* (Idaho) $n = 12$. Fig. 4. *K. polifolia* (Connecticut) $n = 24$. Fig. 5. *K. polifolia* × *K. microphylla* (Nova Scotia × Washington) 14 II, 8 I: n congruent to 36. Magnif. × 2,600.

amined to verify the chromosome number. The haploid chromosome number of all the species is 12, with the exception of *Kalmia polifolia* ($n = 24$). Photomicrographs (Figures 1-5) verify the counts reported and illustrate the small size of the chromosomes.

A summary of the evidence suggesting that *Kalmia microphylla* should be treated as a species distinct from *K. polifolia* follows: 1) The two taxa are geographically separated, *K. microphylla* occurring in western North America at high elevations and *K. polifolia* occurring to the east of the Rocky Mountains and at lower elevations. 2) The plants are different physiologically: *K. microphylla* is a low growing plant adapted to a very short growing season as might be expected of an alpine species. When cultivated under Connecticut conditions it flowers about May 1 and the pollen mother cells undergo meiosis about mid-June, approximately two weeks before *K. polifolia*. 3) The two taxa have completely different crossing relationships with other species in the genus (Jaynes 1968). *Kalmia microphylla* forms hybrids only with *K. polifolia*, whereas the latter taxon can, with difficulty, form hybrids with three other species: *K. angustifolia*, *K. hirsuta*, *K. latifolia*. 4) The chromosome numbers of the two taxa are different (Table 1). Metaphase I chromosome counts of F_1 hybrids of *K. polifolia*-*K. microphylla* using plants of the following sources: Oregon × Saskatchewan, Oregon × Maine, Nova Scotia × Washington, and New Hampshire × Washington indicate that the hybrids are triploids with $2n = 36$, but the exact number was difficult to verify because of univalents, bivalents, and secondary associations. Figure 5 is atypically clear in this regard, but even here there is some uncertainity in distinguishing bivalents from univalents. As would be expected, all the hybrids between the two taxa are highly sterile. Pollen fertility as determined by acetocarmine staining was 0-15% for the hybrids as compared to 90% or higher for the parental taxa. On the basis of all the preceding information it is concluded that *K. microphylla* is a valid species and not a variety of *K. polifolia*.

Table 1. Chromosome numbers and geographic source of *Kalmia* species.

Species	Geographic source	*n*
K. angustifolia L.	North Carolina	12
K. cuneata Michx.	North Carolina	12
K. hirsuta Walt.	Alabama	12
K. latifolia L.	Connecticut	12
K. polifolia Wangenh.	Connecticut	24
"	Minnesota	24
"	New Hampshire	24
K. microphylla (Hook.) Heller	Idaho	12
"	Oregon	12
"	Washington	12

Voucher specimens of the material examined have been placed in the herbarium of the Connecticut Agricultural Experiment Station.

Attempts to produce a tetraploid *Kalmia microphylla* with colchicine for the purposes of comparing it to *K. polifolia* have been unsuccessful. But it seems highly unlikely that a doubling of the chromosome number of *K. microphylla* would produce a plant with the longer internodes, rangy habit, and other characteristics of *K. polifolia*. The presence of normal bivalents during meiosis in *K. polifolia* and the apparent lack of trivalents or secondary associations are additional reasons to believe that this species is not an autotetraploid of *K. microphylla*. It also appears unlikely that *K. polifolia* is an allotetraploid of *K. microphylla* and one of the other presently known *Kalmia* species since *K. microphylla* is unable to cross with the other species. However, *K. polifolia* may have originated as an allotetraploid from a hybrid between *K. microphylla* and an ancestral, presently non-existent, species of *Kalmia*.

SUMMARY

Kalmia polifolia and *K. microphylla* have commonly been treated as varieties of *K. polifolia* but from cytological, physiological, geographic, and genetic evidence presented in this report it is concluded that they are valid species. The chromosome number of *K. polifolia* is verified as $n = 24$. *K. microphylla*, *K. angustifolia*, *K. cuneata*, and *K. hirsuta* are reported for the first time, $n = 12$, and *K. latifolia* is verified as $n = 12$.

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NEW HAVEN 06504

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CYTOTAXONOMIC NOTES ON THE SPECIES OF CIRSIUM NATIVE TO THE SOUTHEASTERN UNITED STATES

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All of the southern thistles are classified under the subgenus *Eucirsium*, section *Onotrophe* of Petrak (1917). Following a modified version of Petrak's classification, the chromosomal relationships of the southern species may be summarized as follows:

Subgenus EUCIRSIUM, Section ONOTROPHE

Subsect. ODORATA: $2n = 30, 32, 34, (33, 35)$. *C. pumilum*, *C. repandum*, *C. lecontei*, *C. horridulum*, *C. vittatum*.

Subsect. CAMPANULATA: $2n = 24, (26)$. *C. nuttallii*

Subsect. ACANTHOPHYLLA:

Series ALTISSIMA (including series Mutica): $2n = 18, 20, (21, 22, 23, 30, 31)$. *C. altissimum*, *C. terrae-nigrae*, *C. discolor*, *C. muticum*, *C. carolinianum*.

Series PANICULATA: $2n = 22, (23, 24)$. *C. texanum*.

Series UNDULATA: $2n = 26, (22\text{-}34)$. *C. undulatum*.

Series VIRGINIANA: $2n = 28$. *C. virginianum*.

We know of no prior published records of chromosome counts for the following species: *C. repandum* Michx., *C. lecontei* T. & G., *C. vittatum* Small, *C. nuttallii* DC., *C. terrae-nigrae* Shinners, *C. carolinianum* (Walt.) Fern. & Schub., *C. texanum* Buckl. and *C. virginianum* (L.) Michx.

Much of the material used in these studies was obtained from plants brought in from the wild and subsequently grown in the greenhouse over a period of several months. The remainder came from seedlings obtained from seeds, also from the wild, some of which were grown to maturity.

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Root tips were obtained and subsequently handled as described by Ownbey & Hsi (1963) and by Ownbey (1968). Preparations for observations of meiotic stages were made according to procedures described by Ownbey, l.c. Voucher specimens for nearly all of the chromosomal records have been deposited in the herbarium of the University of Minnesota.

Sect. ONOTROPHE, Subsect. ODORATA

The *Odorata* as circumscribed here includes three species groups of equivalent taxonomic rank. The first group is formed of *C. pumilum* and *C. repandum*, the second of *C. lecontei* and the third of *C. horridulum* and *C. vittatum*. We have transferred *C. repandum* and *C. lecontei* from Petrak's subsect. *Campanulata* of the sect. *Onotrophe* as we believe this reflects their actual genetic relationships.

1. **Cirsium pumilum** (Nutt.) Spreng. subsp. **pumilum**. $2n = 30$

NORTH CAROLINA. CHATHAM CO.: Route 64, 4 miles east of the Chatham County courthouse, Pittsboro, *Olson & Ownbey* 836, (2 plants).

Chromosomal information for this species is consistent with that from earlier reports by Ownbey & Hsi (1963) and Frankton & Moore (1966) based upon specimens from Connecticut, Massachusetts and New York. Our specimens

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Figs. 1-18. Chromosomes of *Cirsium* drawn with camera lucida, all × 1000. Fig. 1. *C. altissimum*, *O. & O.* 802, $n = 9$. Fig. 2. *C. altissimum*, *O. & O.* 802, $2n = 18$. Fig. 3. *C. carolinianum*, *O. & O.* 797, $n = 10$. Fig. 4. *C. carolinianum*, *O. & O.* 797, $2n = 20$. Fig. 5. *C. discolor*, *O. & O.* 837, $2n = 20$. Fig. 6. *C. horridulum*, *O., O. & Thieret* 798, $n = 16$. Fig. 7. *C. horridulum*, *O., O. & Thieret* 798, $2n = 32$. Fig. 8. *C. lecontei*, *O. & O.* 807, $2n = 32$. Fig. 9. *C. muticum*, *O., O. & Thieret* 799, pl. 1, $2n = 20$. Fig. 10. *C. muticum*, *O., O. & Thieret* 799, pl. 6, $n = 10$ II + 1 I. Fig. 11. *C. muticum*, *O., O. & Thieret* 799, pl. 6, $2n = 21$. Fig. 12. *C. muticum*, *O., O. & Thieret* 799, pl. 6, $2n = 22$. Fig. 13. *C. muticum*, *O., O. & Thieret* 799, pl. 3, $2n = 23$. Fig. 14. *C. nuttallii*, *O. & O.* 810, $2n = 24$. Fig. 15. *C. nuttallii*, *O. & O.* 825, $2n = 26$. Fig. 16. *C. pumilum*, *O. & O.* 836, $2n = 30$. Fig. 17. *C. repandum*, *O. & O.* 828, $2n = 30$. Fig. 18. *C. terraenigrae*, *O. & O.* 791, $2n = 18$.

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from North Carolina indicate that the sporophytic number of 30 is constant for the species throughout its range. One or two additional chromosomes may be present in hybrids of *C. pumilum* with plants of *C. horridulum* having a sporophytic number of 32, as demonstrated by Moore & Frankton, l.c. Hybrids may appear spontaneously where the two species occur together.

2. **Cirsium repandum** Michx. $2n = 30$

NORTH CAROLINA. WAYNE CO.: 7 miles southeast of Goldsboro turnoff, Route 70, *Olson & Ownbey* 835, (2 plants).

SOUTH CAROLINA. BERKELEY CO.: 7.3 miles northeast of Summerville, Route 17A, *Olson & Ownbey* 828, (1 plant); 7.8 miles northeast of McClellanville Post Office, Route 17, *Olson & Ownbey* 831, (1 plant).

Although our data for this species are minimal, the sporophytic chromosome number is probably 30 throughout its range. It is closely related to *C. pumilum*, having the same chromosome number and similar morphological features.

3. **Cirsium lecontei** T. & G. $2n = 32$

FLORIDA. WALTON CO.: 1.0 mile west of Santa Rosa Beach, Route 98, *Olson & Ownbey* 807, (1 plant).

MISSISSIPPI. HANCOCK CO.: 7.2 miles west of Waveland, Route 43 (1 mile west of junction of routes 90 and 43), *Olson & Ownbey* 804, (1 plant).

Our limited chromosomal data indicate that this species belongs in the subsect. *Odorata*. It is a distinctive species of wetland habitats and in this regard differs from other members of the subsection.

4. **Cirsium horridulum** Michx. $2n = 32$ (33, 34)

FLORIDA. FRANKLIN CO.: 1 mile west of Apalachicola, *Olson & Ownbey* 808, $2n = 32$ (1 plant), 33, 34 (1 plant).

GEORGIA. GLYNN CO.: just north of Brunswick along Route 17, *Olson & Ownbey* 824, (1 plant).

LOUISIANA. BATON ROUGE PARISH: just south of Port Allen, *Ownbey* 3621, (3 plants). LAFAYETTE PARISH: northern environs of Lafayette, *Olson, Ownbey & Thieret* 798, $n = 16$, (1 plant), $2n = 32$ (3 plants).

MISSISSIPPI. FORREST CO.: 3.2 miles north of Maxie, Route 49, *Olson & Ownbey* 806, (1 plant).

NORTH CAROLINA. ONSLOW CO.: 7.6 miles north of Folkstone, *Olson & Ownbey* 834, (3 plants).

TEXAS. HARDIN CO.: just north of Silsbee, *Ownbey* 3623, (2 plants). PANOLA-RUSK CO. line: 8.4 miles northeast of Mt. Enterprise (9.9 miles southwest of Clayton), *Ownbey* 3625, (2 plants).

This species had a chromosome number of $2n = 32$ in all collections examined during this study with a single exception from Franklin Co., Florida where the number was 33 or 34 in one plant. Lewis, Stripling & Ross (1962) reported counts of $2n = 34$ for two collections, one from Franklin Co., and one from Leon Co., Florida. Moore & Frankton (1966) report $2n = 34$ in one collection of this species from Massachusetts. They also report hybridization of this species with *C. pumilum* in Massachusetts.

Cirsium horridulum is very closely related to *C. vittatum* and it is often difficult to distinguish them, especially as to herbarium specimens. In the field, *C. horridulum* appears to be a larger and coarser plant with predominantly ochroleucous flowers which appear earlier in the spring. Populations which we classified as *C. vittatum* consisted of more slender, branched plants with lavender flowers appearing later in the spring. *C. horridulum* is found from eastern Texas to New England in the coastal and adjacent states; *C. vittatum* is of more restricted distribution in Florida and the coastal areas of the southeastern states.

Natural hybridization between *C. horridulum* and *C. vittatum* is to be expected and, in fact, the difficulties of separating the two may be due to this factor. Extensive analysis of this species complex is much needed.

5. **Cirsium vittatum** Small. $2n = 32, 34$ (33, 35)

FLORIDA. CITRUS CO.: 1.6 miles south of Crystal River, Route 19, *Olson & Ownbey* 812, $2n = 32$ (2 plants), 33 (1 plant). CLAY CO.: ca. 1.2 miles south of the junction of routes 218 and 21 (on 218) near Middleburg, *Olson & Ownbey* 823, $n = 16 + 1$ (1 plant), $2n = 33$ (1 plant), 35 (1 plant). COLLIER CO.: just west of Paolita Sta., Route 41, *Olson & Ownbey* 814, $2n = 32$ (1 plant), 34 (2 plants), 35 (1 plant). DADE CO.: just south of Florida City, *Olson & Ownbey* 815, $2n = 32$ (3 plants), 34 (2 plants); about 1 mile southeast of Kendall, east of Route 1, *Olson & Ownbey* 816, $2n = 32$ (1 plant). VOLUSIA CO.: 7.6 miles southeast of Pierson (2 miles southeast of Barberville), *Olson & Ownbey* 819, $2n = 32$ (1 plant), 33 (2 plants), 34 (1 plant),

34, 35 (1 plant). WAKULLA CO.: 1 mile west of Newport, Route 98, *Olson & Ownbey* 809, $2n = 32$ (3 plants).

SOUTH CAROLINA. GEORGETOWN CO.: southwestern outskirts of Andrews, Route 41, *Olson & Ownbey* 829, $2n = 32$ (4 plants). DORCHESTER CO.: northern environs of Summerville, *Olson & Ownbey* 827, $n = 16$ (1 plant), $2n = 32$ (2 plants).

This species is characterized by variation in the sporophytic chromosome number even within a single population. Normally, the number appears to be 32 or 34, but accessory chromosomes which are morphologically indistinguishable from those of the regular complement are sometimes present. In one instance the chromosome number in cells of a single root tip was not constant, being either 34 or 35.

The differences between *C. vittatum* and *C. smallii* Britt. are inconsequential and we do not attempt to distinguish them. When combined, the older name, *C. vittatum*, must be adopted for the resulting taxon. For comments regarding the distinctions between *C. vittatum* and *C. horridulum*, see the latter species.

Subsect. CAMPANULATA

6. **Cirsium nuttallii** DC. $2n = 24$ (26)

FLORIDA. HERNANDO CO.: 12.8 miles south of Homosassa Springs, Route 19, *Olson & Ownbey* 813, (4 plants). LEVY CO.: 1 mile southeast of Chiefland, *Olson & Ownbey* 811, (4 plants). OKEECHOBEE CO.: 1 mile south of Okeechobee, Route 441, *Olson & Ownbey* 817, (4 plants). PUTNAM CO.: 1.7 miles north of Palatka, Route 17, *Olson & Ownbey* 820, (4 plants). TAYLOR CO.: 1 mile southeast of Salem, *Olson & Ownbey* 810, (2 plants).

GEORGIA. GLYNN CO.: ca. 10 miles north of Brunswick, *Olson & Ownbey* 825, $2n = 24$ (2 plants), 26 (1 plant).

SOUTH CAROLINA. HAMPTON CO.: 0.5 mile south of Hampton-Colleton Co. line, *Olson & Ownbey* 826, (3 plants).

With the exception of a single plant with $2n = 26$, the chromosomal data for this species is very consistent. The species has no close relatives among the southern thistles.

Subsect. ACANTHOPHYLLA, Series ALTISSIMA

We believe that Petrak's series *Mutica* of the *Acanthophylla* should be combined with the series *Altissima* in order to more clearly portray the close chromosomal and morphological relationships of this group of species.

7. **Cirsium altissimum** (L.) Spreng. $2n = 18$

MISSISSIPPI. ADAMS CO.: between Washington and Natchez, *Olson & Ownbey* 802, $n = 9$ (2 plants), $2n = 18$ (3 plants).

OKLAHOMA. LE FLORE CO.: 15.2 miles southeast of Hodgen (5.0 miles southeast of junction of routes 59 and 259), *Ownbey* 3627, (1 plant).

TEXAS. CASS CO.: 1 mile south of Red Hill, Route 8, *Ownbey* 3626, (2 plants).

The sporophytic chromosome number of 18 for the three collections reported here is consistent with earlier counts by Frankton & Moore (1963) and Ownbey & Hsi (1963). The only deviation from this figure was $2n = 20$ reported in one Iowa collection by Ownbey & Hsi, l.c. All earlier counts came from plants from the northern part of the range of the species. The present counts are from the southern and southwestern periphery of the range. Plants from the Mississippi population were taller and with more deeply lobed cauline leaves than is usual in this species.

8. **Cirsium terrae-nigrae** Shinners *(C. filipendulum* Engelm., not Lange). $2n = 18$

TEXAS. ELLIS CO.: 2.0 miles southwest of Bardwell, *Olson & Ownbey* 793, (4 plants). KAUFMAN CO.: 1.4 miles northeast of Scurry, Route 34, *Olson & Ownbey* 791, (5 plants).

This species is closely related to *C. altissimum* with which it shares the same chromosome number, $2n = 18$, the lowest so far recorded for the genus *Cirsium*. Both species develop thickened, fusiform roots which are especially conspicuous during the rosette stage and tend to disappear during formation of the flowering stems.

9. **Cirsium discolor** (Muhl.) Spreng. $2n = 20$

NORTH CAROLINA. ALLEGHENY CO.: along Blue Ridge Parkway west of Cherry Lane, alt. ca. 3600 ft., *Olson & Ownbey* 837, $n = 10$ (1 plant), $2n = 20$ (1 plant).

Chromosomal data for this species has been recorded by Ownbey (1951), Frankton & Moore (1963) and Ownbey & Hsi (1963). The sporophytic number of 20 has been found to be constant except for one seedling studied by Frankton & Moore, grown from Virginia seed, which had 21. The present collection was made in North Carolina at the southeastern extremity of the species range.

10. **Cirsium muticum** Michx. $2n = 20$ (21, 22, 23)

LOUISIANA. LAFAYETTE PARISH: southwestern environs of Lafayette, *Olson, Ownbey & Thieret* 799, $n = 10$ (1 plant), 10 + 1 (3 plants), $2n = 20$ (2 plants), 21 (2 plants), 20, 21, 22 (1 plant), 23 (1 plant).

Earlier reported counts for this species are as follows: Ownbey (1951) and Ownbey & Hsi (1963), $2n = 20$; Frankton & Moore (1963), $2n = 20, 22$. Frankton & Moore reported an apparent case of triploidy in Florida material. They studied five plants with $2n = 30$ and one plant, which exhibited some morphological peculiarities, with $2n = 31$. Preliminary studies of one plant indicated that 15 bodies, presumably bivalents, were regularly present at metaphase I. The additional chromosome in one plant was thought to be due to meiotic irregularity and not to be an accessory chromosome in the usual sense.

Considerable instability in chromosome numbers was seen in plants of *Olson & Ownbey* 799. Pollen mother cells at metaphase showed 10 normally paired bivalents in all plants, but in three plants there was an additional smaller, unpaired chromosome. Root tip cells had 20-23 chromosomes in individual plants. In one plant the root tips differed in their chromosomal complements, having 20, 21 or 22 chromosomes in individual cases. Presumably this could result from mitotic misdivisions of the accessory chromosome. *C. muticum* from Louisiana differs in many small ways from the species as we are accustomed to see it in the northern wetlands. A more detailed experimental study of the southern races of this species would be valuable.

11. **Cirsium carolinianum** (Walt.) Fern. & Schub.
$2n = 20$

TEXAS. POLK CO.: 0.1 mile east of junction of Texas farm roads 942 and 2500, on Route 942 east of Leggett, *Olson & Ownbey* 797, $n = 10$ (2 plants), $2n = 20$ (2 plants).

More chromosomal data for this species is needed, but the data now available indicate that the species is correctly placed in the series *Altissima*. The plants studied came from the southwestern edge of the species range.

Figs. 19-28. Chromosomes of *Cirsium* drawn with camera lucida, all × 1000. Fig. 19. *C. texanum*, *O. & O.* 792, $n = 11$ II + 1 I. Fig. 20. *C. texanum*, *O. & O.* 792, $2n = 23$. Fig. 21. *C. texanum*, *O. & O.* 794, $2n = 22$. Fig. 22. *C. undulatum*, *O. & O.* 795, $2n = 26$. Fig. 23. *C. virginianum*, *O. & O.* 830, $2n = 28$. Fig. 24. *C. vittatum*, *O. & O.* 827, $n = 16$. Fig. 25. *C. vittatum*, *O. & O.* 815, $2n = 32$. Fig. 26. *C. vittatum*, *O. & O.* 812, $2n = 33$. Fig. 27. *C. vittatum*, *O. & O.* 814, pl. 4, $2n = 35$. Fig. 28. *C. vittatum*, *O. & O.* 814, pl. 2, $2n = 34$.

Series PANICULATA

12. **Cirsium texanum** Buckl. $2n = 22$ (23, 24)

TEXAS. BELL CO.: 3 miles south of Temple, *Ownbey & Baker* 2977, $2n = 22$ (1 plant); 4.6 miles south of Temple city limits on the road to Academy, *Ownbey & Baker* 2978, $2n = 22$ (2 plants). DALLAS CO.:

Route 114, 4 miles northwest of the crossing of the Elm Branch of the Trinity River, *Ownbey & Baker* 2972, $2n = 22$ (2 plants). ELLIS CO.: 1.1 miles southwest of Bardwell, *Olson & Ownbey* 792, $n = 11$ (2 plants), $11 + 1$ (1 plant), $2n = 22$ (1 plant), 23 (3 plants), 24 (1 plant). FALLS CO.: 2.0 miles east of Marlin, *Olson & Ownbey* 796, $n = 11$ (3 plants), $2n = 22$ (2 plants). HILL CO.: Lake Whitney State Park, *Olson & Ownbey* 794, $2n = 22$ (2 plants). MC CULLOCH CO.: 9 miles west of Brady city hall, Route 87, *Ownbey & Baker* 2988, $n = 11$ (2 plants), $2n = 22$ (2 plants). PECOS CO.: Tunis Spring, 20 miles east of Ft. Stockton, Route 290, *Ownbey & Baker* 3001, $2n = 24$ (1 plant). SAN PATRICIO CO.: ca. 2 miles southwest of Portland, *Jones s.n.*, $n = 11$ (2 plants), $2n = 22$ (2 plants); 7 miles south of Taft, *Jones s.n.*, $n = 11 + 1$ (2 plants), $2n = 23$ (2 plants). TOM GREEN CO.: Concho River crossing, 2.4 miles northeast of Tankersly, *Ownbey & Baker* 2996, $2n = 22$ (6 plants), 24 (1 plant).

Rather extensive sampling of this species indicates that the sporophytic chromosome number is normally 22, but sometimes is 23 or 24. No meiotic material of plants with $2n = 24$ was studied so it is unknown whether 11 or 12 bivalents are formed at metaphase I. In plants with $2n = 22$, 11 bivalents were seen at metaphase I; in plants with $2n = 23$, 11 bivalents plus 1 univalent were ordinarily present. *Jones s.n.*, from south of Taft, San Patricio Co., Texas, was seen to have 11 bivalents plus 1 univalent or 10 bivalents and 1 trivalent at metaphase I, indicating that the accessory chromosome in this collection is a homologue capable of undergoing normal pairing. Jones (personal communication) states that the two populations from San Patricio Co. were distinguishable in the field both on the basis of morphology and habitat. Possibly the extra chromosome in the one population produces a visible effect in this instance. *C. texanum* is, however, a variable species and there may actually be two distinguishable taxa lumped together under this binomial at the present time. The question is under study.

Although a very common thistle in its natural area, *C. texanum* is not found outside Texas and adjacent Mexico. *Ownbey & Baker* 2988 was collected near the type locality of the species. *Ownbey & Baker* 3001 was collected near the type locality of *Carduus austrinus* Small which, judging from a study of the type specimens of the two, is a synonym

of *Cirsium texanum*. *Carduus austrinus* is based upon *Wright* 1291 which, according to A. Gray (1853, p. 101), came from "Low and grassy flats around Escondido Springs, between the Pecos and the Limpio; June." Escondido Springs, according to Geiser (1935), is situated 19.5 miles east of Comanche Springs (now Fort Stockton). Petrak (1917, p. 419) erroneously lists *Carduus austrinus* Small as a synonym of *Cirsium ochrocentrum* Gray var. *helleri* (Small) Petrak.

Petrak, (l.c., p. 447 et seq.) did not distinguish *C. texanum* Buckl. from what later became *C. terrae-nigrae* Shinners (i.e., *Cirsium filipendulum* Engelm. and synonyms), and the synonyms given by Petrak for *C. texanum*, with the exception of *C. virginianum* var. T. & G. and *C. greenei* Petrak, properly belong under *C. terrae-nigrae*.

Series UNDULATA

13. **Cirsium undulatum** (Nutt.) Spreng. $2n = 26$

TEXAS. HILL CO.: Lake Whitney State Park, *Olson & Ownbey* 795, (4 plants).

This collection comes from the southeastern extremity of the range of the species. The sporophytic chromosome number is the same as reported on all previous occasions. Earlier reports for this species are as follows: Hsi (1960), Frankton & Moore (1961), Ownbey & Hsi (1963), Ownbey & Hsi (in press).

Series VIRGINIANA

14. **Cirsium virginianum** (L.) Michx. $2n = 28$

SOUTH CAROLINA. CHARLESTOWN CO.: 5.3 miles northwest of McClellanville Post Office, *Olson & Ownbey* 830, (2 plants).

No chromosomal irregularities were observed in the very limited sample of this species. The species is not closely allied to others in the area and its relationships to other North American thistles are obscure.

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CONTINUED BOTANIZING ON THE WOLF ISLANDS, NEW BRUNSWICK

BY

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Several species of more than passing interest have turned up on the Wolf Islands since our last report (Rhodora **66:** 413-417, 1964). To make our list complete we shall discuss these and any other new records of vascular plants for the Wolves.

(1) **Typha latifolia** L. During the eighth year of our field work on the Wolf Islands we noticed a small colony of Cat-tail at the northern end of the barrier pond at Southwest Cove on East Wolf Island. We were unable to reach the plants to collect them on that visit because of very high water in the treacherous bog, but in the following year, 1968 we did make collections of vegetative plants and noted that the colony was spreading rapidly. We have visited this pond and adjacent bog many times, starting with nearly our first trip to the islands and even searched in particular for *Typha*, fully expecting to find it since some habitats seemed to us to be ideal for Cat-tails not only here but in other places on both East and South Wolf Islands. Indeed, in one of our papers (Rhodora **66:** 141, 1964) *Typha* was singled out as a remarkable absentee. It is certainly of the greatest interest that, in the many thousands of years that the Wolf Islands have been available for plant colonization, we should happen to be witnesses to the arrival of a weedy and almost ubiquitous species which almost certainly was not introduced by man.

(2) **Poa subcaerulea** Sm. Specimens of what we call *P. subcaerulea* were first collected by us in open turfy areas above ledges at Southwest Cove, East Wolf Island on July 1, 1964. On June 4, 1968, we again collected specimens in the same locality. When we made our first collections, we didn't recognize the species but we believed we were getting something quite different from any grass we had seen before.

Later at the Gray Herbarium we attempted to match specimens with those in the collection in the genus *Poa* where obviously it belonged. Peter Green, working there at the time, looked over our shoulders at our specimens and suggested *Poa subcaerulea* without hesitation. In early 1968 we sent duplicate material to the herbarium at Kew and under correspondence of April 18, 1968, from Peter Green he quotes Dr. Charles E. Hubbard, the eminent grass specialist, who says of it, "The gatherings are both *Poa subcaerulea* Sm. recognized by the acutely acuminate glumes and few panicle branches." Peter Green in the same letter went on to say that Dr. Hubbard was "very interested to see the specimens and confirm the presence of this species in North America from personal observation."

There is in the Gray Herbarium at the present time a folder of specimens of *Poa subcaerulea* at the end of the genus. We have notes on some nineteen of these collections, many of them made by Fernald and his co-workers during his years of active botanizing of areas about the Gulf of St. Lawrence. These specimens were collected all the way from Labrador to Prince Edward Island and Nova Scotia. The range given in Gray's Manual ed. 8, 1950, p. 117 is "Lab.s to Nfld., M. I. and e. N.B." Whatever the range, whether that given in Gray's Manual or a somewhat wider one following the data in the folder of specimens in the Gray Herbarium, the Wolf Island record is considerable of a range extension all the way from Eastern New Brunswick or from the head of the Bay of Fundy.

There are several points of view about *Poa subcaerulea* that demand discussion. One relevant problem relates to the origin of the plant, whether native or introduced. Hultén, 1958 in "The Amphi-Atlantic Plants," p. 10 states of it, "It belongs to a very critical group, the area of which cannot be given for the present. The most reasonable is to regard it as a European plant introduced in Eastern America and elsewhere." Roland and Smith in "The Flora of Nova Scotia," part 1 of the Rev. Ed. 1966, pp. 84-85, treat *Poa subcaerulea* as part of the *P. pratensis* complex but make

the following pertinent observation regarding its status as a native population. "*Poa subcaerulea* appears to be a native coastal type with bluish-tinged spikelets." We agree with their disposition of it as native but consider it to have more distinctiveness than the color of spikelets. Polunin in his "Circumpolar Arctic Flora," 67, 1959, commenting on *P. pratensis sl.* including *P. subcaerulea*, *P. irrigata* and *P. alpigena* states "fully circumpolar in distribution."

From the habitat and occurrence of our Wolf Island specimens we would be inclined, as some others have been, to call the plant native. It seems to us unlikely that *Poa subcaerulea* was brought in from Europe, especially after examining material collected by Fernald and his associates in Western Newfoundland where many of the stations are in wild and remote coastal areas.

The second major problem about *Poa subcaerulea* is its status as a species. In complexes such as that of *Poa pratensis* and its relatives, we ought to consider whether there are distinctive populations that are morphologically unique, are geographically isolated and that presumably have evolved independently. Assuming, as we do, that *Poa subcaerulea* is native along the coast of Eastern America and following Hubbard, Fernald and others, considering it to be morphologically distinct from typical *Poa pratensis*, we are prepared to accept *Poa subcaerulea* as a species that must have evolved out of the *P. pratensis* complex at some fairly remote time. This is further shown by its disjunct occurrence on both sides of the Atlantic. Often the specific lines separating *P. pratensis* from related species are blurred, perhaps largely because of interfertility between the related taxa and consequent introgression. Hybridization is so very common in many plant groups in nature that the great swarms of confusing hybrids, often wrongly interpreted, tend to obscure the evolutionary lines. It seems to us, at this time, that *Poa subcaerulea* merits treatment as a species closely related to *Poa pratensis*.

(3) **Carex deflexa** Hornem. Reported erroneously as *C. Emmonsii* Dew. (Rhodora **65**: 89, 1963) and discussed as to

its occurrence on the Wolves (Rhodora **66:** 144-145, 1964). Our first station, in turf over ledges bordering the sea was very limited, there being few plants. We were fortunate in 1967 to find a more extensive growth of the same sedge in a more inland situation on South Wolf Island. Careful study in the herbarium rules out *C. Emmonsii* for either station and make it evident that we have here the more northern *C. deflexa.* In our 1964 paper (loc cit) we had demonstrated the boreal character of the Wolf Island flora contrasted to that of Grand Manan, the presence of *Carex Emmonsii* being an anomalous and disturbing matter since it might, with more likelihood, have been on Grand Manan because of its more southern affinities rather than on the Wolves. Now that the plant is recognized as *C. deflexa,* which fits the boreal pattern of the Wolf Island flora, our thesis is strengthened. Incidentally, *Carex deflexa* has not been collected on Grand Manan.

The earlier collection named *C. Emmonsii* by error should be changed to *C. deflexa.* It is our *Pike* & *Hodgdon* no. 17787.

(4) **Carex pallescens** L. var. **neogaea** Fern. A widely distributed sedge of not pronouncedly northern distribution. We have found this but once in an open area near the southwestern end of the barrier beach at Southwest Cove on August 17, 1967. There are many records on Grand Manan and there is nothing startling about its presence on East Wolf Island, except its extreme scarcity, there being but one plant seen.

(5) **Rumex orbiculatus** Gray. Edge of barrier pond at Southwest Cove, East Wolf Island, September 19, 1964. Even at this late time of year the fruits were still so immature that they proved to be nearly useless as aids to identification. However, the valves of the calyx lack teeth or bristles while other features of the plant including the very large leaves and the wet habitat preference belong to *R. orbiculatus.*

(6) **Heracleum maximum** Bartr. A single large plant growing beside the stairway leading to the lighthouse on South Wolf, August 17, 1967. We had passed this way many times in earlier years and hadn't seen it. This part of the

Wolf Islands had been occupied more extensively than any other part and probably this merely represents the reappearance of a species that had been there at some previous time and had been dormant at the time of our early visits.

(7) **Solidago puberula** Nutt. A widely distributed goldenrod fairly common on Grand Manan. Only a few specimens were seen on East Wolf Island at the edge of the bog at Paul's Cove on September 6, 1965, the only station we have found on the Wolves. The specimens were small but otherwise quite typical.

In 1964 (Rhodora **66:** 413-416, 1964) we provided some statistics on the flora of the Wolf Islands. These we will now revise, incorporating all additions and changes since then.

Table I

Total taxa on the Wolf Islands — 338

	East Wolf	South Wolf	Fat Pot	Flat Wolf	Gull Rock
Comparative areas of islands	42	12	6	3	1
Taxa recorded	302	169	107	96	35
Ratio of taxa to area	7.2	14.1	19.5	32	35

Some changes are also required in the statistics on boreal taxa of the Wolf Islands and Grand Manan. The initial comparison of these two groups of islands showed that the Wolf Islands had 43 boreal taxa of which 33, confined to the Wolves, could be regarded as boreal disjuncts while Grand Manan had a total of only 22 boreal taxa. The boreal *Betula papyrifera* var *cordifolia*, which is very common on the Wolves and which we had reported from Grand Manan (Rhodora **64:** 100-101, 1962) should have been added at that time to the Grand Manan list making 23 boreal taxa, of which 11 were shared with the Wolves.

With the further addition of 3 boreal taxa to the Wolf Islands, one of which was shared with Grand Manan (Rhodora **64:** 413-416), the total of Wolf Island boreal taxa then would have become 46 rather than the reported 45 and the taxa shared with Grand Manan, 12 rather than 11.

In this paper we are adding 2 more boreal species confined to the Wolf Islands, *Poa subcaerulea* and *Carex deflexa*, bringing the total of boreal taxa on the Wolf Islands to 48, while in the current paper on Grand Manan (Rhodora **71:** 306, 1969) one additional boreal species *Salix pellita* is reported from that group of islands and the taxon *Anaphalis margaritacea* var *subalpina* is also newly reported from Grand Manan though found previously on the Wolf Islands. A tabular up-to-date summary of the boreal taxa on the two island groups is given in table 2.

Table 2

Boreal taxa on Wolf Islands and Grand Manan

Total boreal taxa	On Wolf Islands	On Grand Manan	Shared
60 (100%)	48 (80%)	25 (41.7%)	13 (21.7%)

It is evident that further collecting on the Wolf Islands and on Grand Manan continues to support the thesis that the Wolf Islands have a remarkably prominent boreal element in their flora contrasted to that of Grand Manan.

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ISOTRIA MEDEOLOIDES ON THE PIEDMONT OF VIRGINIA

Plant distribution on the Piedmont of Virginia is more poorly known than for any physiographic province of the state. Aside from a northern portion of the Piedmont where Washington botanists frequently collect, and Amelia County where Mr. J. B. Lewis worked many years ago, collections from this part of Virginia are scanty and come from scattered localities. Travel in the area quickly demonstrates the reasons for a paucity of collections. The Piedmont is botanically uninteresting compared with other regions of Virginia, and it is difficult to find good collecting grounds. Oak-hickory and pine forests form much of the dominant vegetation and few habitats are available for rare and local species.

Dr. G. W. Ramsey with his coworkers, and the author with much help from many interested persons, are making concerted efforts to close gaps in our knowledge of plant distribution and ecology of the region. A result of this work is the discovery of several relict areas which have an important bearing on the ecology and vegetational history of Virginia.

Such an enclave with many relict populations occurs in southern Buckingham County. Here soils of lower wooded slopes have very high calcium, magnesium, and pH values, and in these soils grow many plants which are rare or unknown elsewhere in the Piedmont. Among localized species are *Carex jamesii* Schwein., *Tradescantia virginiana* L., *Trillium sessile* L., *Cypripedium calceolus* L., *Ostrya virginiana* (Mill.) K. Koch, *Ulmus rubra* Muhl., *Draba ramosissima* Desv., *Rhus aromatica* Ait., *Euonymus atropurpureus* Jacq., *Aesculus octandra* Marsh., *Hybanthus concolor* (Frost.) Spreng., *Panax quinquefolius* L., *Phlox divaricata* L., *Conopholis americana* L., *Campanula americana* L., *C. divaricata* Michx., and *Polymnia canadensis* L. Many popu-

lations within the general area are localized colonies of few individuals.

Many of these species have one or more outliers on the coastal plain where they are edaphic relicts of more widespread distributional patterns of the past. Since these localized plants have their main population centers in the mountains to the west, we were greatly surprised to find a single individual of the rare *Isotria medeoloides* (Pursh) Raf. formerly known also as *Pogonia affinis*, in the Buckingham County area. Barbara J. Harvill found the orchid growing on a wooded north-facing slope. Dr. Donovan Correll kindly confirmed its identity. This pogonia is extremely rare in Virginia and was heretofore known only on the coastal plain (Baldwin, 1968; Grimes, 1921; Taylor, 1934). The discovery adds another species to those with remarkable disjunct populations in Virginia.

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A RHODE ISLAND STATION FOR LUMINOUS MOSS: Owing to the apparent scarcity of *Schistostega pennata*, it seems worthwhile to record a station for it in Rhode Island. The moss occurs in a graphite mine in the town of South Kingstown, Washington County.

The Indians reportedly first worked this vein of graphite and called the area Cajoot. As late as the 1890's graphite was mined there, and the Schistostega has come in since then. In 1956 when David Nichols was surveying the Narragansett Pier, R.I. quadrangle for a surface geology map, his father, Reginald Nichols, who accompanied him, noted the glowing moss and took color photographs of it.

The moss grows in a north-facing tunnel located part way down the twenty-foot mine pit. It does not grow at the very mouth of this tunnel but begins at about six feet in and extends further another yard. At no time between May and September when I observed did the sun's direct ray fall on the moss habitat; hence probably it does not at any other time. *Schistostega* grows only on the floor of this cavern, not ascending the walls, and it seems more partial to flat, moist chunks of graphite than to the crumbled earth between them. Its glow at this particular site is best viewed at a forty-five degree angle with some variation either way.

Despite traffic in the form of youngsters exporing the abandoned mine, the moss survives although in less quantity than when first seen in 1956. A specimen has been deposited at the University of Rhode Island Herbarium by Dr. Richard Hauke of the Botany Department.

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MORE ADDITIONS TO THE FLORA OF GRAND MANAN, NEW BRUNSWICK

In 1962 (Rhodora **64**: 98-102) six new taxa were reported for Grand Manan Island to be added to the Weatherby and Adams Flora (A list of the Vascular Plants of Grand Manan, Contr. Gray Herbarium LVIII, 1945). During the summer of 1965, one of the present authors (Harry Tyler) then an undergraduate student at the University of New Hampshire, acted as a summer instructor at the Gerrish House Society which is located at Grand Harbour. He made particular use of his time in searching for additions to the list of Grand Manan plants. The following taxa reported in this paper were all collected by Tyler and, like those newly reported in 1962, are deposited in the Herbarium of the University of Hampshire (NHA).

Salix pellita Anderss. In roadside gravel at North Head. The specimen lacked catkins but had leaves with silky-velvety lower surfaces and essentially entire or obscurely serrate margins, satisfactorily matching representative herbarium material of *S. pellita*.

Polygonum aviculare L. var. **vegetum** Ledeb. White Head Island. This suberect and broad-leaved variety of the heteromorphous *P. aviculare* often occurs in the Bay of Fundy area. Although Weatherby and Adams did not distinguish varieties in this complex it might be well to do so now considering the great difference between this plant and the more common typical weedy form.

Lynchnis alba Mill. In dry soil at Castalia. Both male and female plants were collected and the female flowers had 5 styles which distinguishes it from the often confused *Silene noctiflora* L. Its white flowers and long attenuate sepals characterize *L. alba*.

Sorbaria sorbifolia (L.) A. Br. Thicket by road at Whale Cove. This seems to have been an escaped colony, but

may represent only persistent plants from earlier cultivation. In any event it should probably be counted as part of the natural flora of the islands.

Pyrus floribunda Lindl. Ingall's Head. No flowers or fruits were present but the densely pubescent young twigs and lower leaf-surfaces eliminate the more common *P. melanocarpa* (Michx.) Willd. which was reported by Weatherby and Adams.

Pyrola elliptica Nutt. Deciduous woods at Castalia. The relatively long and thin blades and the many-flowered long-cylindric racemes serve to characterize this species. The numerous specimens collected are all typical.

Lysimachia quadrifolia L. In gravel along a back road at Grand Harbour. The perfectly typical specimens leave no doubt about the identification. The presence of the species in Washington County, Maine would certainly lead one to expect the plant in New Brunswick and perhaps more particularly on Grand Manan since Weatherby and Adams comment on certain affinities of the Grand Manan Flora to that of southern Maine. We have seen specimens from Machias and Steuben in Washington Co. but, so far as we can determine, this is the first record from the Maritime Provinces.

Mentha arvensis L. var. **arvensis.** Weed at Grand Harbour. The two small specimens collected in flower, have the leaves definitely broadest below the middle and rounded abruptly at the base to the short petioles. This variety, probably introduced, is widely distributed and to be expected. However, Weatherby and Adams stated in particular that the *Mentha arvensis* that they had seen from Grand Manan was the var. *villosa* (Benth.) S. R. Stewart.

Anaphalis margaritacea (L.) C. B. Clarke var. **subalpina** Gray. Gravelly back road at Grand Harbour. The varieties of *Anaphalis margaritacea* are not always clearly defined but within a certain range of variation

the numbers of leaves and distribution of pubescence on them seem to be reasonably good characters. The two specimens at hand at early maturity have about 36-38 leaves, the upper ones, just below the inflorescence, of good size and all leaves somewhat floculent-tomentose above. Weatherby and Adams had identified their Grand Manan material as var. *intercedens* Hara. It is interesting that careful search on Grand Manan has not yet disclosed the conspicuous var. *margaritacea* with its bright green upper leaf-surfaces which is common on the nearby Wolf Islands.

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REVISION OF THE GENUS DAHLIA (COMPOSITAE, HELIANTHEAE — COREOPSIDINAE)

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The genus *Dahlia* (Compositae, Heliantheae — Coreopsidinae) famed because of its numerous ornamental forms of gardens, was named by Cavanilles in 1791 honoring Andreas Dahl, a Swedish botanist and pupil of Linnaeus. It is composed of four sections, twenty-seven species, and four infraspecific taxa and is largely restricted to the highlands (1500-4300 meters elevation) of México and Central America. Two species, *Dahlia coccinea* and *D. imperialis*, are also found in some countries of South America where they are believed to have been introduced. The genus encompasses some extremely diverse life forms ranging from dwarfed perennial herbs scarcely over four decimeters tall *(D. scapigera)* to huge arborescent plants which, in some instances, ascend to eight or nine meters *(D. imperialis)*, and to scrambling epiphytic vines which sprawl among the treetops in rain forest *(D. macdougallii)*. The great majority of the species have extremely restricted ranges, but one *(D. coccinea)* may be considered a roadside weed and is very wide-ranging throughout México and Guatemala.

Most historical accounts of the genus *Dahlia* have dealt with its rather important role in horticulture. Little or no attention has been given the fact that the genus is composed first of all of a group of wild species some of which have served as the progenitors of our garden subjects. Similarly workers who have written about the wild species have seldom taken into account the aspects of the genus in horticulture. As is discussed in detail later in this work, there appear to be just two of the naturally occurring species of *Dahlia* which have been involved, through processes of hybridization and selection, in the production of the numerous garden forms now known in cultivation the world over. In the past many hybrid variants were singled out and erroneously given formal taxonomic rank and provided with

Latin names, often also with Latin and vernacular diagnoses. Such treatment of these cultivars has given them the semblance of being botanical species. The purpose of the present study is to direct attention primarily to the systematics of the wild species where they occur naturally, while borrowing from the horticultural literature such names and information as are appropriate in clearing up misunderstandings in nomenclature. Elsewhere I shall present a full exploration of the history of *Dahlia* from the viewpoint of its cultivation dealing at length with its role in horticulture.

The formal history of *Dahlia* begins in the late 18th Century in Spain when Antonio José Cavanilles described and illustrated *Dahlia pinnata* in volume one of his *Icones et Descriptiones Plantarum*, 1791. Cavanilles, then a senior member of the staff of the Royal Botanic Garden in Madrid (not the director as has so often been repeated in articles on *Dahlia*, see Colmeiro, 1875), had received seeds of Mexican plants from Vicente Cervantes, a botanist at the Mexican Botanic Gardens in the city of México. Plants grown from these seeds were cultivated in Madrid and they formed the basis of the material used by Cavanilles to prepare the six volumes of his *Icones* issued during the years 1791-1801. Among these seeds were those of the original *Dahlia pinnata* as well as some of two additional species, *D. rosea* and *D. coccinea* which Cavanilles subsequently described in volume three of the *Icones*, 1796. Thus from the beginning Dahlias have been plants of gardens.

During the 17th and 18th centuries Europeans had a lively interest in the plants being brought back from the New World and botanical institutions freely exchanged seeds of noteworthy introductions. In this atmosphere Dahlias were, within a matter of a few years, found in the major botanic gardens of France, Italy, Germany and England. Presumably the earliest source of these plants was Madrid whence the gardens of France and England received their seeds, but meanwhile other plant collectors had also introduced *Dahlia* seeds into Europe from México. In any case, it is clear by the large numbers of variants which arose

among the plants in their gardens that Dahlias were creating a mild sensation among European horticulturists of the time.

Willdenow was the first to present a generic treatment of *Dahlia*. In his ed. 4 of *Linneaus' Species Plantarum*, 1803, he included the three species described by Cavanilles but he adopted in place of *Dahlia*, the name *Georgina* believing that *Dahlia* Cav. was preoccupied by *Dahlia* Thunberg (1792) of the Hamamelidaceae for which Persoon subsequently substituted the name *Trichocladus*. Although *Georgina* eventually came to be widely used, and is today a vernacular name for the garden Dahlia in Scandinavia and the countries east of the Rhine, botanists of the time mostly recognized Willdenow's error in dates and continued to publish notices, using the name *Dahlia*. In 1804, Thouin, working from material of the genus under cultivation in the gardens of the Paris Natural History Museum, published what must be taken as the first treatise on the cultivation of *Dahlia*. At the same time he offered a brief taxonomic review of the species accompanied by the world's first published colored portrait of them. This portrait must have caused considerable interest because almost at once it was reproduced in several gardening journals of the period and undoubtedly helped to create further enthusiasm for these new garden plants. Willdenow, in 1809, again revised his classification of *Georgina* recognizing two species. One of his species was given the aptly chosen name *G. variabilis* under which he placed all of the cultivated forms with ligules of purple, lilac, or rosaceous colors. For these he gave the varietal names of *purpurea*, *lilacina*, and *pallida*. Similarly, he placed all of the scarlet, orange, and yellow-rayed forms under *G. coccinea* and provided the corresponding varieties *coccinea*, *crocea*, and *flava*. One can appreciate Willdenow's problem as the number of Dahlias developed in gardens created an ever-increasing and bewildering array of new and different forms. The name *variabilis* seemed to fit the garden Dahlia so well that it was immediately adopted almost to the exclusion of all others.

The following year, 1810, de Candolle, seemingly in deference to the lead established by Willdenow, published a revision of *Dahlia* under the name *Georgina*. This paper appeared in the Annals of the Paris Natural History Museum whose editors added a disclaimer stating they were publishing the paper just as de Candolle requested despite their feeling that the name *Dahlia* should have been used. The generic treatment offered by de Candolle is very similar to that of Willdenow on the infraspecific level but for *G. variabilis* Willd. he substituted *G. superflua* and for *G. coccinea* (Cav.) Willd., *G. frustranea*. These new names had a brief acceptance but de Candolle himself even submerged them in the synonymy of his treatment of *Dahlia* for the *Prodromus* (1836). In 1829, Desfontaines offered in his ed. 3 of the *Catalogus Plantarum Horti Regii Parisiensis*, the combination *Dahlia variabilis* (Willd.) Desf. in the synonymy of which he placed Willdenow's *Georgina variabilis* and de Candolle's *G. superflua*. Since that time, *Dahlia variabilis* has become widely used and persists even in current literature as the name for the cultivated garden Dahlia.

During the remainder of the 19th and in the early years of the 20th centuries, several more species of *Dahlia* were described. A good summary of the taxonomy and nomenclature of the genus was offered by Hemsley in 1879 and again in 1881. Between the time of Hemsley and the present the greatest contributions to our understanding of the wild *Dahlia* species came from the work of E. E. Sherff who, at the time of his death, April 1966, was regarded as a leading authority on this and other genera of the Compositae. In 1930, in connection with his monographic work on the Compositae, Subtribe Coreopsidinae, Sherff described *D. linearis* and thereafter regularly published notes including descriptions of several more new taxa until, in 1955, for an installment of the *North American Flora*, he contributed the most recent systematic treatment of the genus. Here he recognized 29 taxa, including 18 species, 8 varieties, and 3 forms. In the present treatment, one section, six species, and two varieties are proposed as new. Of the 29 taxa recog-

nized by Sherff 12 are maintained here, six are reduced to synonymy and ten are recombined at different taxonomic levels.

Table 1. Conspectus of the species and summary of chromosome numbers of the Genus *Dahlia*.

Section 1. Pseudodendron Sherff

1. *D. excelsa* Benth.
2. *D. imperialis* Roezl ex Ortgies ($n = 16$)
3. *D. tenuicaulis* Sorensen, sp. nov. ($n = 16$)

Section 2. Epiphytum Sherff

4. *D. macdougallii* Sherff

Section 3. Entemophyllon Sorensen, sect. nov.

5. *D. scapigeroides* Sherff
6. *D. foeniculifolia* Sherff
7. *D. linearis* Sherff ($n = 17$)
8. *D. rupicola* Sorensen, sp. nov. ($n = 17$)
9. *D. dissecta* S. Wats
   - 9a. var. *dissecta* ($n = 17$)
   - 9b. var. *sublignosa* Sorensen, var. nov.

Section 4. Dahlia

10. *D. merckii* Lehm. ($n = 18$)
11. *D. apiculata* (Sherff) Sorensen, comb. & stat. nov.
12. *D. cardiophylla* Blake & Sherff ($n = 16$)
13. *D. purpusii* Brandg.
14. *D. pinnata* Cav. ($n = 32$)
15. *D. pteropoda* Sherff
16. *D. brevis* Sorensen, nom. nov. ($n = 16$)
17. *D. rudis* Sorensen, sp. nov.
18. *D. moorei* Sherff
19. *D. hintonii* Sherff
20. *D. mollis* Sorensen, sp. nov. ($n = 16$)
21. *D. atropurpurea* Sorensen, sp. nov. ($n = 32$)
22. *D. australis* (Sherff) Sorensen, comb. & stat. nov.
    - 22a. *var. australis* ($n = 16$ & 32)
    - 22b. var. *liebmannii* (Sherff) Sorensen, comb. nov.
    - 22c. var. *chiapensis* Sorensen, var. nov.
    - 22d. var. *serratior* (Sherff) Sorensen, comb. & stat. nov.

23. *D. sherffii* Sorensen, sp. nov. ($n = 32$)
24. *D. scapigera* (A. Dietr.) Knowles & Westc. ($n = 16$)
25. *D. barkerae* Knowles & Westc. ($n = 32$)
26. *D. tenuis* Robinson & Greenman ($n = 16$)
27. *D. coccinea* Cav. ($n = 16$ & 32)

Evidence supporting the taxonomic and nomenclatural changes herein proposed for the genus *Dahlia* has been gathered from three main avenues of research: field studies of the intra- and interpopulational variability, morphologic studies using both living materials and herbarium specimens, and chromosomal studies. Pertinent data are discussed where appropriate in connection with the taxonomic treatment of the species to which they apply. However, it is useful at this point to offer a brief explanation of the mode of morphologic variability found among the species and to call attention to certain features of the foliage and the terminology used. Also, for the purposes of the present treatment, the principal details of the chromosomal studies are outlined below. A full report on this phase of the research will be presented elsewhere.

Chromosomal Studies

Chromosome numbers are now known for 17 taxa of the genus *Dahlia* as follows (see also Table 1):

$n = 16$	7 *spp.*
$n = 17$	3 *spp.*
$n = 18$	1 *sp.*
$n = 16$ & 32	2 *spp.*

Ishikawa (1911) was the first to publish a report on *Dahlia* chromosomes. He found the numbers of *D. variabilis* (i.e., *D. pinnata*) and *D. coronata* (i.e., *D. coccinea*) to be $2n = 64$ and 32 respectively. *Dahlia imperialis* was reported to have 32 ($n = 16$) chromosomes by Belling (1924) and in 1929 Lawrence added a report on *D. merckii* ($n = 18$). Thus, at the outset of this study, three of the four numbers found in the genus were known. The fourth,

$n = 17$ (*D. dissecta*,[1] *D. linearis*, and *D. rupicola*), is reported here for the first time.

Several interesting remarks may be made concerning the distribution of chromosome numbers within *Dahlia*. In some instances the chromosome numbers correlate remarkably with morphologic data. This is demonstrated particularly well among the taxa of the newly described section Entemophyllon which on morphologic grounds are clearly allied. All are diploids and all have the same chromosome number, $n = 17$. Moreover, the aneuploid *D. merckii*, $n = 18$, comes morphologically closest to the members of this section. Similarly, the two species of "tree-dahlias" of section Pseudodendron are diploids and share the same chromosome number, $n = 16$. The only tetraploids ($n = 32$) known in the genus occur within the section Dahlia where they number about as many as the diploids. Two of the species, *D. coccinea* and *D. australis*, are composed of both diploid and tetraploid races. A majority of the species have rather restricted geographic ranges and it is significant that most of these are diploids. Notable exceptions are *D. merckii* and *D coccinea* which are rather wide ranging though the tetraploid races of *D. coccinea* extend over a much greater area than do the diploid.

Morphological Considerations

The size, shape, and segmentation of the compound leaves of some *Dahlia* species are extremely variable. To promote clarity in the use and understanding of the keys and descriptions a brief explanation is provided below of the type of materials, the technical characters, and the terminology employed in the systematic treatment. It is hoped that this will also serve as a guide to the type of materials one should gather when making future collections of *Dahlia*.

a) All descriptions of the species are based upon data derived from mature plants collected in the field, not greenhouse-grown individuals. The latter often

[1]A previous report (Turner *et.al.*, 1962) of the chromosome number of *D. dissecta* as $n = 18$ was based on a specimen (*Rock M-351* [TEX]) of *D. merckii*.

exhibit altered characters such as smaller leaf segments and longer petioles. Plants in their first year of growth from seed usually produce juvenile foliage unlike that on the same individual grown from tubers in later years.

b) Measurements of stems and leaves are based on *median* leaves and adjacent portions of the stems.

c) Length of leaves includes the petiole and terminal leaflet.

d) Width of leaves is measured at the basal pair of leaflets or lobes.

e) Length of leaflets is based solely on the *basal* pinna and is measured from the primary rachis to the tip of the terminal pinnule. In the same manner, the length of pinnules is measured from the rachilla to the tip of the basal pinnule on that axis. The necessity of designating, in this way, precisely which portion of the leaf is being measured is seen from the selected types of leaves portrayed in Fig. 1. Note that the basal pinna and pinnules are always the largest and that they diminish greatly in size the more distal they are.

f) Shapes of leaflets are of the blades of ultimate segments as, for example, in the case of bipinnate leaves, the basal pinnule of the basal pinna. Exceptions to this occur in some descriptions when specific reference is made to another segment such as the terminal leaflet or terminal pinnule.

g) The petiole is measured from the stem to the junction of the basal pair of leaflets. In the case of pinna-

Fig. 1. Selected leaf types × ½ and their corresponding petiolar cross-sections × 2 of *Dahlia spp.* A. a compound leaf with alternate pinnules, *Dahlia rupicola;* B. a compound leaf with alternate pinnules, *Dahlia merckii;* C. a compound leaf with opposite pinnules, from an artificial hybrid, *Dahlia australis* var. *australis* × *coccinea;* D. a pinnatissect leaf, *Dahlia pinnata;* a. *stipel,* note the compound stipels on the leaf of A; b. *rachis internode;* c. *rachis node.*

A
B
a
C
D
a
b
c

tifid leaves (Fig.1-D) when the limits of the petiole are not clear, measurements are from the stem to the junction of the first (i.e. basal or proximal) pair of main lateral veins. Petiolules and pseudopetiolules are measured in the same way.

h) Petiolar cross-sections are taken from a point midway between the stem and basal pair of leaflets or main lateral veins. Types encountered are shown in Fig. 1. If working with dried material it is possible to see clearly all the diagnostic features of these cross-sections following hydration in warm water.

i) The junction of the primary rachis with the secondary rachis or rachilla is termed a "rachis node". Consequently, a "rachis internode" denotes the portion of the axis between the junctions of successive pairs of leaflets (see Fig. 1).

j) The leaves of various species within *Dahlia* may be sorted into four main classes: simple leaves, compound leaves with alternate pinnules (Fig. 1-A, & -B), compound leaves with opposite pinnules (Fig. 1-C), and pinnatifid or pinnatisect leaves (Fig. 1-D). The degree of dissection of compound leaves, whether once-pinnate, bi-, or tri-pinnate, has been based solely on the basal pinnae.

k) The occurrence of *stipels*, as seen in the leaves of Fig. 1-A, -B, & -C) is diagnostic with some species and not so with others. Attention is being called to them so the user may be aware of the structure to which the term refers.

l) The principal diagnostic features of the heads are the rays (for their color) and the outer whorl of involucral bracts (for their position, size, shape, and ornamentation). In all cases, the character-

istics of these structures are based on heads in anthesis.

The nature of the materials needed for the identification of most *Dahlia* species is implicit in the foregoing notes. However, the species of the section Pseudodendron, the so-called "tree-dahlias", require special mention. Most leaves of these species are too large to collect intact. A single leaf may measure 80 to 90 centimeters long. Collectors should select a single basal pinna of a median leaf and supplement the specimen with notes on total length of the leaves and the number of primary leaflets. Notes should also be made concerning the height and habit of the plants. Collections of the suffrutescent species should include a portion of the two-year-old stem.

Various authors and collectors have, at times, confused species of *Dahlia* and *Cosmos*. This has been particularly true of *Cosmos diversifolius* which is easily mistaken for *Dahlia scapigera*, and *D. brevis* which has been identified as *Cosmos concolor*. At anthesis *Cosmos* species are distinguished by a cylindrical brush of hairs on each of the five staminal filaments, while in species of *Dahlia* the filaments are smooth. In fruit the achenes of *Dahlia* are obcompressed and mostly 2-sided or slightly 3-angled in cross-section, those of *Cosmos*, quadrangular. The fleshy outer involucral bracts of *Dahlia*, especially as seen in fresh material, are quite distinct from the thin bracts of *Cosmos*. Species of the closely allied and deceptively similar *Hidalgoa*, often called climbing-dahlia, are distinguished by their sterile disc florets, and their petioles which twist and cling in the manner of *Clematis*.

I cannot conclude this introduction without acknowledging with sincere thanks the help of many persons — Dr. Thomas E. Melchert, University of Iowa, for suggesting the study and guiding me from its beginning; Dr. George W. Martin, Professor Emeritus, for his advice and encouragement over the years; Daniel J. Crawford, for his companionship in the field in México and assistance with other phases of

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During two field trips through México and Central America I was able to collect 18 of the 31 taxa recognized here. In addition to recollecting many poorly known species and making extensive observations of natural populations, I was able to gather propagating materials of species which had never before been brought under cultivation. Being able to observe living materials of the species pass through their life cycle greatly added to my present understanding of the genus. The study is otherwise based on herbarium specimens borrowed from the following institutions (the standard abbreviations of Index Herbariorum are used consistently throughout this work):

A	Arnold Arboretum, Harvard University
BH	Bailey Hortorium, Cornell University
CAS	California Academy of Sciences
DS	Dudley Herbarium, Stanford University
F	Field Museum of Natural History
GH	Gray Herbarium, Harvard University
IA	The University of Iowa
ISC	Iowa State University
MEXU	Herbario Nacional, Instituto de Biología, Universidad Nacional de México
MICH	University of Michigan
MSC	Michigan State University
MO	Missouri Botanical Garden
NY	New York Botanical Garden
POM	Pomona College
RSA	Rancho Santa Ana Botanic Garden
TEX	University of Texas

UC University of California
US U. S. National Herbarium, Smithsonian Institution
WIS University of Wisconsin

I am grateful to the curators of these herbaria for the loan of specimens. I should like also to acknowledge the assistance of the National Science Foundation whose grant (No. GB-3851) to Dr. Thomas E. Melchert helped to defray the expenses of the field work.

Specimens cited in the lists of exsiccatae are arranged in a geographic sequence by country from east to west. The states of México are in order more or less by tier from north to south and within each tier from east to west. A complete first set of my own collections from México and Guatemala is on deposit at IA.

SYSTEMATIC TREATMENT

Dahlia Cav. Icones et Descr. Pl. 1: 56. 1791. Type species: *Dahlia pinnata* Cav. (see Sherff, 1955.)

Georgina Willd., Linn. Sp. Pl. ed. 4. 3: 2124. 1803. Type species: *Georgina purpurea* Willd.

Georgia Sprengel, Anleitung zur Kenntniss der Gewächshe, ed. 2. 2: 567. 1818. Type species: *Georgia variabilis* Willd.

Scrambling epiphytes, herbaceous or suffrutescent perennials, developing from fascicled tubers or with the rootstock tuberously thickened, in one epiphytic species the roots aërial *(D. macdougallii)*. Stems erect, rarely vine-like, arising singly (sect. Dahlia), 2-4 (sect. Pseudodendron), or many in a cluster (sect. Entemophyllon), the individual stems mostly unbranched except in the flowering portion or branching freely from the base *(D. merckii)*; internodes hollow or solid, sometimes the pith chambered (sect. Entemophyllon); nodes septate or the septa sometimes incomplete. Leaves opposite or whorled (3 per node); simple to 3-pinnately compound, often stipellate; margins ciliolate or eciliolate. Heads radiate, on long, slender, naked peduncles; involucral bracts distinctly bi-seriate, the outer (4-)5(-6-7) erect, spreading or reflexed at anthesis, fleshy, dorsally several-lined, green, narrowly linear to broadly ovate or obovate, the inner (7-)8(-9), membranous, many-lined, variously tan, red, reddish-brown or brown, often the tips colored purple or red, margins scarious or white-hyaline, ovate, subacute, obtuse, or emarginate, enlarging in fruit

to about twice their size at anthesis; chaff scarious, light tan suffused with red or purple, resembling the inner bracts but with fewer lines, subtending each disc floret, ovate, obtuse or subacute; ray florets neutral or pistillate sterile, rays white or whitish-lavender to deep purple or yellow to various shades of orange to deep blackish-scarlet, narrowly or broadly ovate, acute, often minutely denticulate, sometimes the veins dorsally minutely pubescent; disc florets yellow, yellow with red or purple tips or the limb purple throughout, 17-172 per head, hermaphrodite, fertile, tubular (all or some replaced by sterile or fertile ligulate florets in many horticultural forms), corolla expanded into a 5-toothed, cylindrical limb, the teeth erect, spreading, recurved or strongly revolute; filaments glabrous; style branches linear-lanceolate, bearded dorsally for ¾ their length, ventrally near the tips only, spreading or slightly reflexed at anthesis. Achenes grayish-black to black at maturity, more or less linear to linear-oblanceolate, rarely broadly spatulate, obcompressed, obscurely sulcate, sometimes puberulent (minutely tuberculate in sect. Entemophyllon), often slightly constricted just beneath summit and capped by a shallow tan disc (or the disc swollen and black in *D. moorei*); pappus obsolete or consisting of 2 minute rudiments, these sometimes elongated to 1 mm., rarely greatly elongated into weak, flexuous filiform, often caducous, threads. Chromosome numbers, $n = 16$, 17, 18, and 32.

KEY TO THE SECTIONS

A. Plants liana-like, producing aërial roots to 22 m. long; stems scrambling for great distances in the tree tops of rain forest west of Tehuantepec. ..... Sect. 2. Epiphytum.

A. Plants growing erect, not vine-like; roots tuberous and anchored in the soil, not aërial.

B. Plants suffrutescent, 21-90 dm. tall; ligneous stems of the previous year 1.5-10 cm. diam.; pinnules opposite on the rachilla. ..... Sect. 1. Pseudodendron.

B. Plants herbaceous, 4-30 dm. tall or subshrubs 9-15 dm. tall, if the latter, then the ligneous stems of the previous year 0.3-2 cm. diam.; pinnules opposite or alternate on the rachilla.

C. Pinnules or pinnular segments invariably alternate on the rachilla; petioles solid; leaves bipinnatisect to bipinnate-pinnatisect. ..... Sect. 3. Entemophyllon.

C. Pinnules or pinnular segments opposite on the rachilla or if alternate then the petiole hollow or the leaves merely simple. ..... Sect. 4. Dahlia.

KEY TO THE SPECIES

Section 1. Pseudodendron

A. Principal leaves 50-90 cm. long

B. Primary pinnae 3-7; outer involucral bracts linear. ..... 1. *D. excelsa.*
B. Primary pinnae 9-15; outer involucral bracts obovate or oblanceolate. ..... 2. *D. imperialis.*
A. Principal leaves 20-43 cm. long. ..... 3. *D. tenuicaulis.*

Section 2. Epiphytum

One species. ..... 4. *D. macdougallii.*

Section 3. Entemophyllon

A. Outer involucral bracts 5-9 mm. long; petioles solid.
B. Peduncles 1.5-10 cm. long; outer bracts acute; current year's growth developing from woody stems, these usually with chambered pith. ..... 7 *D. linearis.*
B. Peduncles 12-37 cm. long; outer bracts obtuse or subacute; plants herbaceous or with short (5-15 cm.) lengths of the previous year's stems becoming slightly woody, sometimes with chambered pith.
C. Plants herbaceous; heads 3.5-6 cm. diam. ..... 9a. *D. dissecta* var. *dissecta.*
C. Plants subherbaceous, short (5-15 cm.) lengths of the previous year's stems becoming slightly woody (or with some stems herbaceous, having developed directly from the tuberous rootstock); heads 5.5-8.5 cm. diam. ..... 9b. *D. dissecta* var. *sublignosa.*
A. Outer involucral bracts 9-18 mm. long; petioles solid or hollow.
D. Stems living more than one season and branching to produce the current season's growth; petioles solid.
E. Ultimate segments or their lobes (whichever are narrower) of median leaves 0.5-3.2 mm. wide. ..... 8. *D. rupicola.*
E. Ultimate segments of median leaves 5-16 mm. wide. ..... 5. *D. scapigeroides.*
D. Stems living only one season, the current season's growth arising from a crown or tuberous rootstock beneath the soil; petioles solid or hollow.
F. Petioles solid. ..... 6. *D. foeniculifolia.*
[F. Petioles hollow. ..... 10. *D. merckii* (of Sect. 4. Dahlia)]

Section 4. Dahlia

A. Outer involucral bracts reflexed at anthesis (sometimes merely spreading but not ascending).
B. Median leaves compound or if simple then the petiole more than 3 mm. long.
C. Rays white, whitish-lavender, light purple to dark blackish purple.
D. Current year's growth branching from ligneous stems of the previous year. ..... 11. *D. apiculata.*

D. Current year's growth from subterranean tubers or rootstock.
E. Petioles broadly auriculate-winged at the base, 1-4.2 cm. wide, upper surface of leaves glabrous or essentially so, lower surface pilose or merely pubescent; stem 6-furrowed. ..... 15. *D. pteropoda.*
E. Petioles without wings or if winged then not forming broad auricles at the base.
F. Leaves and stems densely soft pubescent, pilose on lower surfaces of leaves (hairs diminishing on branches of the inflorescence and on parts of the heads). ..... 20. *D. mollis.*
F. Leaves and stems not densely pubescent nor pilose.
G. Outer involucral bracts flagelliform with long-attenuate tips, 10-17 mm. long, broadest at or near the base, 1.5-4 mm. wide; achenes 6-8 mm. long, constricted slightly below the summit to form a black disc less than 1 mm. wide and barely 0.4 mm. high. ..... 18. *D. moorei.*
G. Outer involucral bracts not long flagelliform, sometimes acuminate, but the tips not long attenuate, broadest at or beyond the middle.
H. Outer involucral bracts 14-24 mm. long, dorsally glabrous.
I. Rachis, petiole and petiolule usually winged; the terminal leaflet or segment with (11-)12-15 teeth per side; blades flexible when dry, surfaces not strongly bi-colored; outer bracts (4-)5-10 mm. wide. ..... 17. *D. rudis.*
I. Rachis, petiole and petiolule not conspicuously winged; the terminal leaflet or segment with 3-9(-11) teeth per side; leaflets brittle and stiff when dry, surfaces bi-colored, the lower usually lighter green; outer bracts 2-6 mm. wide. .... 22d. *D. australis* var. *serratior.*
H. Outer involucral bracts 2-12(-14) mm. long, if longer then dorsally pilose.
J. Petioles solid, more than 1.2 cm. long.
K. Outer involucral bracts glabrous on the dorsal suface or with a few scattered hairs.
L. Rays drying to dark blackish purple; outer bracts ventrally appressed pubescent; leaflets (ex-

cept sometimes the terminal leaflet or segment) rounded at the base; hairs along the midrib beneath widely spaced, 12 or fewer per cm. ..... 21. *D. atropurpurea.*

L. Rays drying to rose or light purple.

M. Leaves coarse textured, often scabrous, simple or more commonly pinnatisect to pinnate-pinnatisect; rachis, petiole and petiolule winged, often broadly so; margins coarsely toothed, the teeth protruding beyond the outline of the blades; basal pinna or lobe longer than the petiole. .... 14. *D. pinnata.*

M. Leaves upon drying becoming stiff but not coarse textured nor scabrous, 1- or 2- pinnate.

N. Upper surface of leaves rugose, glabrous or a few scattered hairs near the apex, lower surface conspicuously lighter green or silvery green; margins revolute or obscurely so; native in Oaxaca, Chiapas and Guatemala. .... 22. *D. australis* incl. vars. *chiapensis* & *serratior.*

N. Upper surface of leaves smooth, not rugose, with scattered or broadly spaced antrorsely curved hairs and lines of very minute hairs following the main veins; lower surface not or but slightly lighter green; margins flat; native in Chihuahua, Durango and northern Zacatecas. .... 23. *D. sherffii.*

K. Outer involucral bracts copiously hairy or pilose on the dorsal surface. ..... 19. *D. hintonii.*

J. Petioles hollow or if solid then 0.8-1.2 cm. long.

O. Leaves (including petiole) 14-38 cm. long; petiole hollow, 4-16 cm. long. ..... 10. *D. merckii.*

O. Leaves (including petiole) 5.5-8 cm. long; petiole solid, 0.8-1.2 cm. long. ..... 22b. *D. australis* var. *liebmanii.*

C. Rays yellow, orange, orange-scarlet or deep blackish scarlet.

P. Leaves (including petiole), 6-11 cm. long, pinnate-pinnatifid or pinnate-pinnatisect; plants 2.5-6 dm. tall; rays yellow. ..... 26. *D. tenuis.*

P. Leaves (including petiole), 12-35 cm. long, simple to 3-pinnate; plants 4.5-30 dm. tall; rays yellow, orange, orange-scarlet or deep blackish scarlet. ..... 27. *D. coccinea.*

B. Median leaves simple, not lobed nor divided, sessile or the petioles 1-3 mm. long.

Q. Base of blade clasping the stem, the leaves sessile; margins with 5-8 teeth per side. ..... 12. *D. cardiophylla.*

Q. Base of blade narrowed or rounded, the leaves sessile or short stalked, the petiole 1-3 mm. long; margins with 10-18 teeth per side. ..... 13. *D. purpusii.*

A. Outer involucral bracts erect or at least ascending at anthesis.

R. Leaves without stipels; outer bracts 4-7 mm. wide. ..... 16. *D. brevis.*

R. Leaves usually with stipels present at the 1st and/or 2nd rachis node; outer bracts 1.8-3 mm. wide.

S. Outer bracts 6-6.5 mm. long; leaves (esp. on the undersurface and stems conspicuously hairy, the hairs shiny white, 2-5 mm. long, clearly multi-cellular; leaflets glossy dark green and rugose above. ..... 25. *D. barkerae.*

S. Outer bracts 7-11 mm. long; leaves and stems glabrous or sparsely pubescent at the nodes on the stem and rachis, sometimes also dorsally along veins of leaflets; leaflets pale green and rugose above. ..... 24. *D. scapigera.*

Section 1. Pseudodendron Sherff, Am. Jour. Bot. 38: 69. 1951. Type species: **Dahlia lehmannii** Hieron. (= *Dahlia imperialis* Roezl ex Ortgies)

Suffrutescent perennials 2-6(-9) m. tall, stems becoming woody and often lasting more than one season, the older ones (1.5-)2-10 cm.

diam., internodes hollow, nodes strongly septate, leaves 1-, 2- or 3-pinnate, the principal ones 20-90 cm. long, apices of ultimate segments long attenuate, midveins tan colored beneath, heads obliquely erect or pendulous, numerous, rays white or whitish-lavender to light or rosaceous purple. (Species 1-3.)

1. **Dahlia excelsa** Benth. in Maund, Botanist. 2: *pl. 88.* 1838. TYPE: MEXICO: Valley of México (the exact locality not stated), 7 Oct. 1834, *William Bates s.n.* (Holotype: K; photo. of type: F!).

   Dahlia excelsa var. *anemonaeflora* Benth. *Ibid.* Type: that of *D. excelsa* Benth.

   Dahlia variabilis var. *excelsa* (Benth.) Walpers, Suppl. Prim. ad Rep. Bot. Syst. 2: 602. 1843. Type: that of *D. excelsa Benth.*

   "Roots fascicled, some perennial, cylindrical, and fibrous, others swelling into tubers. STEM perennial, very thick, becoming woody, growing to the height of twenty feet and upwards, less branched, and assuming more the aspect of a tree than any other species, hollow inside, smooth and glaucous on the surface, marked with horizontal rings formed by the broad stem-clasping base of the petioles, and sometimes emitting near the base a great quantity of fibrous roots. LEAVES opposite, attaining the length of two feet and a half, by about two feet in breadth, doubly pinnatipartite, the general petioles broadly connate round the stem, the segments borne on sharp partial footstalks, those of the lower leaves ovate and heart-shaped at the base, those of the upper leaves, especially the end ones, often contracted at the base, acuminate, toothed, nearly smooth or with a few short scattered hairs, of a pale glaucous green underneath. FLOWER HEADS on long opposite monocephalous peduncles, collected five to eight together in a sort of corymb at the end of the branches, with occasionally a few axillary solitary ones along the stem. OUTER INVOLUCRE consisting of five or six linear spreading foliaceous squamae, the inner one of about twelve, oblong, obtuse, erect, membranous ones. FLORETS in the specimen we have seen all altered from their natural state, so as to give to the head of flowers the form known in other Dahlias by the name of anemone-flowered.

The florets of the ray appear to be nearly in their ordinary state, and to be naturally neutral and sterile, those of the disk are shorter but all converted into irregularly formed semi-ligulate sterile florets having lost their original colour to assume that of the ray. All traces of the organs of fructification are obliterated in all the florets."

The foregoing is quoted directly from Bentham (1838) who based his description of *Dahlia excelsa* on living specimens. For the present study the only material I have been able to examine are two photographs (housed at F) of the type specimens. Sherff (1951a) writes of having collected *Dahlia excelsa* in two places in Guatemala, September, 1949, under his numbers *5061*, "Chichicastenango . . . garden at the south side of Santo Thomás church," and *5062*, "roadside thicket above Sololá." In an effort to obtain additional specimens for study I revisited these localities, in the company of Dr. T. E. Melchert and Mr. D. J. Crawford, during late summer, 1966. Our search for this species was unsuccessful. At the garden of the Santo Tomás church we observed a large plant of *Dahlia imperialis*. It resembled the typical wild plants of that species we had seen in great numbers along roadsides in the general vicinity of Sololá earlier that day.

Later an effort was made to locate Sherff's collections of *Dahlia excelsa* referred to above. It was expected these would be deposited in the herbarium of the Field Museum in Chicago. Other *Dahlia* specimens were found there which Sherff had collected in Guatemala during the same trip, September, 1949, but his numbers *5061* and *5062* were not found. Nevertheless, I have assumed that Sherff did, in fact, have the benefit of additional material of *Dahlia excelsa* on which to base his amplified description which he offers of the species in North American Flora (Sherff, 1955). From his description the following salient features may be added to Bentham's original description given above:

". . . the larger leaves 6-7.5 dm. long including the glabrate petiole (this more or less 2 dm. long), 4-6 dm.

wide, their primary divisions (pinnae) each with but 1-5 leaflets (the terminal one often irregularly 2-3-parted), . . . margins coarsely serrate (with up to 21 teeth on a side), . . . ultimate segments to 1.7 dm. long and about 7 cm. wide; flowering heads . . . about 9 cm. across, . . . outer involcral bracts 5 or 6, linear . . . ligules lilac, oblong, about 3.5 cm. long, about 1.5 cm wide, . . . achenes not seen."

Valley of México (?) southeastward to southwestern Guatemala above Sololá.

In addition to the problem of the identity of *Dahlia excelsa* there is the question of the place of origin of the type. Bentham (1838) writes, "The Dahlias are all native in the mountainous districts of México, where the present species *Dahlia excelsa* had probably been discovered some years ago, as it appears to have long been cultivated in the Botanic Garden of the City of México." As seen in its photograph, the type in the Hooker Herbarium (K) bears a handwritten label stating the plant was collected in the Valley of México, but there is no mention on the label of a botanic garden. One wonders, therefore, how Bentham could have known about its having "long been cultivated in the Botanic Garden of the City of México," except had not William Bates, the collector, so informed him. Although it is not specifically stated, the indication is that the original material was collected by Bates in a Botanic Garden and he, perhaps assuming the plant had been introduced from nearby mountains, merely noted on the label the "valley of México." Certainly this region of México is botanically the best-known in that country, yet no specimens from this area, of *Dahlia excelsa* or any other "tree-dahlia," have been seen, except two specimens of *Dahlia imperialis* which have come from contemporary gardens.

On the characteristics displayed in the photographs of the type, *Dahlia excelsa* may be distinquished from *Dahlia imperialis* by its 3-7 (not 9-15) primary leaflets and from the new *Dahlia tenuicaulis* by the overall length of its leaves, "6-7.5 dm. long including the . . . petiole" (not 20-43

cm. long). Despite these distinctions and despite the unfortunate lack of material by which to judge, I strongly feel that *Dahlia excelsa* and *Dahlia imperialis* are variants of the same species. Nevertheless, I have chosen to retain *Dahlia excelsa* in the present treatment on a provisional basis.

2. **Dahlia imperialis** Roezl ex Ortgies in Regel, Gartenflora **12:** 243. 1863. TYPE: exact place and date of collection not known; the plants collected in México by Roezl, brought to Zurich where cultivated, then to Berlin, the Royal Botanic Gardens, where cultivated and described, *Roezl s.n.* (Holotype: B[?]).

Dahlia arborea Hort. ex Regel, Cat. Pl. Horti Aksakoviano 1860. *nomen nudum.*

Dahlia maximiliana Hort. ex Hooker f. Bot. Mag. *pl.* 7655. 1899. This name also used in Gard. Chron. II. **11:** 216 & 12: 525. 1879, but without adequate description. Lectotype: *pl.* 7655, Hooker f. *loc. cit.*

Dahlia lehmannii Hieron. Bot. Jahrb. **19:** 55. 1894. Type: *Lehmann* 4894, Colombia (Holotype: B[?]; Isotype: F!).

Dahlia dumicola Klatt, Bot. Beibl. zur Leopoldina 6. 1895 & Bull. Soc. Bot. Belg. **35:** 289. 1896. Lectotype: *Pittier & Tondue* 8469, Costa Rica (F!).

Dahlia maxonii Safford, Jour. Washington Acad. **9:** 371. 1919. Type: *Maxon & Hay* 3295, Alta Verapaz, Guatemala (US!).

Dahlia lehmannii var. *leucantha* Sherff, Am. Jour. Bot. **38:** 70. 1951. Type: *Austin Smith A*-620, San Luis de Zarcero, Costa Rica (F!).

Herbaceous or suffrutescent perennial, 2-6(-9) m. tall. Stems of the previous year becoming woody, 7-10 cm. diam.; stems of the current year essentially unbranched except in the flowering portion, 1-4 cm. diam., hollow but septate at the nodes, smooth, obscurely 6-angled, glaucous, green or reddish-green when fresh, when dry becoming minutely many-striate with conspicuous lenticels, surface of older portions rough and tan or brown with enlarged lenticels. Leaves 50-90 cm. long, 2- or 3-pinnate; primary leaflets 11-15, basal pinnae of principal leaves 20-38 cm. long; simple basal pinnules of lowest pinnae 5.5-14 cm. long, 3.5-6 cm. wide, ovate to oblong elliptical, acuminate or rarely merely acute at tips, mostly tapered or rounded at base, sometimes truncate or subcordate, sessile or stalked, the stalks rarely exceeding 5 mm.; the upper surface green, with hairs of two kinds, those on the nerves minute and appressed, those between the nerves longer, erect or slightly bent, the lower surface lighter green

or gray-green, reticulate veiny, with hairs long, flexuous, conspicuously multi-cellular, mostly following the nerves; margins obscurely or conspicuously ciliolate, regularly and more or less evenly serrate with (6-)10-18 teeth per side; stipels occurring irregularly, when present then usually at the fourth rachis node but sometimes at more proximal nodes as well, infrequently also at the first node on the basal rachilla; petiole 12-25 cm. long, adaxially flattened or longitudinally grooved, abaxially rounded, glabrous, solid or sometimes hollow, strongly dilated and fleshy at the base, connate with the petiole base of the opposite leaf to form a conspicuous cupule at the node; rachis glabrous except for a cluster of hairs at the junctions with the primary pinnae, adaxially grooved, becoming narrowly winged esp. in the distal portions. Heads numerous, sometimes 150-300 per plant, obliquely erect to slightly nodding (pendulous in some horticultural clones), 9-15 cm. diam., slightly campanulate at anthesis; outer involucral bracts reflexed at anthesis, 6-14 mm. long, 3-9 mm. wide, obovate or oblanceolate, obtuse or acute, rarely subacuminate, dorsally many-striate, glabrous, ventrally appressed pubescent, the hairs stramineous or brown; inner bracts 15-25 mm. long, 7-13 mm. wide, ovate, obtuse, many-lined, brown with hyaline margins; rays white or whitish-lavender to rose-purple, 3.5-6 cm. long, 1.5-3 cm. wide, elliptical or ovate, acute or subacute, denticulate, tube of the ligulate florets pubescent, the hairs sometimes gland-tipped; disc florets 128-172, yellow or yellow with reddish tips, 9-11 mm. long, corolla lobes reflexed and inwardly curled; style branches about 3 mm. long, less than 1 mm. wide, lanceolate-attenuate, sometimes abruptly rhomboid-broadened near the middle; chaff (in fruit) about 2 cm. long, brown, sometimes with reddish or purple tips; achenes 13-17 mm. long, 1.8-2.5 mm. wide, linear or slightly oblanceolate. Chromosome number, $n = 16$.

Rocky slopes and fields, 2500-9000 ft., central Chiapas southeast in Guatemala, San Salvador, Costa Rica, and Colombia. Flowering Sept.-Feb. Map 1.

MEXICO. CHIAPAS: from 3 to 10 mi. E. of San Cristóbal de las Casas along route 190, *Breedlove* 7300 (DS, F, MICH), *Carlson* 1613 (F), *Melchert et al.* 6462 (IA), 6464 (IA), *Miranda* 9188 (MEXU), *Moore & Cetto* 8189 (BH, MEXU), *Nelson* 3173 (GH, US [2]); vicinity of Tenejapa, *Breedlove* 6814 (DS, F), 7233 (DS, F[2]); 5 mi. S. of Jitotól, *Breedlove* 8878 (DS, F); Cerro Ovando, *Matuda* 2233 (GH, MEXU, MICH, US); Cerro Male, *Matuda* 4628 (MO, NY); near Motozintla, *Matuda* 15452 (MEXU). COSTA RICA. without specific locality, *Stork* 2992 (F). ALAJUELA: San Luis de Zarcero, *Austin Smith* A620 (F, MO), H236 (F, MO), NY1369 (F, GH, NY). SAN JOSE: Las Nubes, Coronado, *Echevarria* 160 (F, UC), *Stork* 4722 (GH, MICH, NY, UC); Santa María de Dota, *Standley* 41857 (GH, US). EL SAL-

Map 1. Distribution of *Dahlia imperialis* Roezl ex Ortgies.

VADOR. AHUACHAPAN: Apaneca, *Calderon* 2422 (F, US). SANTA ANA: Volcán de Santa Ana, *Tucker* 1297 (UC). GUATEMALA. ALTA VERAPAZ: vicinity of Cobán, *Standley* 69469 (F), 90887 (F), 91114 (F); Socoyocté, *Maxon & Hay* 3295 (Type of *D. maxonii* — US); above Santa Cruz, *Standley* 71026 (F). CHIMALTENANGO: Chichavác, *Skutch* 65 (US), 711 (GH); above Las Calderas, *Standley* 80260 (F). CHIQUIMULA: vicinity of El Barriol, *Steyermark* 30774 (F). GUATEMALA: NE. of Guatemala City, *White* 5142 (MICH). HUEHUETENANGO: vicinity of San Mateo Ixtatán, *Steyermark* 49887 (F); *Breedlove* 8761 (DS, F); above Concepción, *Goodman & Melhus* 3691 (F, ISC); near Huehuetenango, *Melchert et al.* 6452 (IA); vicinity of Tunima, *Steyermark* 48418 (F). JALAPA: vicinity of Jalapa, *Steyermark* 32110 (F), 32406 (F), 32547 (F), *Standley* 77180 (F), 77228 (F). JUTIAPA: Volcán Suchitán, *Steyermark* 31903 (F). QUETZALTENANGO: vicinity of Santa María de Jesús, *Standley* 67162 (F); 84874 (F); slopes of Volcán Santa María, *Steyermark* 34414 (F), 34415 (F); slopes of

Volcán Zunil, *Standley* 67468 (F), *Steyermark* 34676 (F); SE. of San Martin Chile Verde, *Standley* 83790 (F), SE. of Palestrina, *Standley* 84205 (F); along route 1, E. Quetzaltenango, *Melchert et al.* 6434 (IA). SACATEPEQUEZ: slopes of Volcán de Agua, *Bell & Duke* 16972 (MICH, UC), *Hunnewell* 14869 (GH), *Standley* 59425 (F); near Antigua, *Kellerman* 7096 (F, MICH, NY, US); San Rafael, *J. D. Smith* 2857 (F, US); above Las Calderas, *Standley* 59972 (F) barranca above Duenas, *Standley* 63214 (F). SAN MARCOS: along road between San Marcos and San Rafael Pié de la Cuesta, *Standley* 85320 (F), 86289 (F, GH); Cenaguilla, *Heyde & Lux* 4239 (F, GH, MO, NY, US). SOLOLA: E. of Sololá along road above Lake Atitlán, *Melchert et al.* 6439 (IA), 6443 (IA). TOTONICAPAN: 5 mi. E. of Quetzaltenango, *Melchert et al.* 6434 (IA). COLOMBIA. CALDIAS: Río Quindío, above Armenia, *Pennell et al.* 8677 (GH, NY, US). CAUCA: Vicinity of Popayán, *Cuatrecasas* 23407 (F), *Fosberg* 20290 (NY, US), *Killip & Lehmann V* 38056 (GH, UC, US), *Lehmann* 4894 (Holotype of *D. lehmannii* — B [?], Isotype — F); *Sneidern* 5677 (US); El Tambo, *Sneidern* 1035 (F, GH, NY). CUNDINAMARCA: vicinity of Bogotá, *Ping* 157 (F, MO), *Soejarto* 281 (GH); between El Salto and El Colegio, *Cuatrecasas* 8185 (F, US); Taguate Valley, *Grant* 9652 (US); Subatá, *Haught* 6114 (US); near Charquito, *Langenheim* 3359 (UC); barranca del Río Bogotá, *Schultes et al.* 4045 (US). HUILA: Río Balsallas, *Rusby & Pennell* 929 (GH, NY, US). SANTANDER: E. slope of Paramo del Hatico, *Killip & A. C. Smith* 20558 (A, GH, NY, US); valley above Suratá, *Killip & A. C. Smith* 16530 (GH, NY, US). The following specimens from cultivation: GUATEMALA. SACATEPEQUEZ: near Antigua, *Sherff* 5054 I, II, III, IV, V (F). MEXICO. DISTRITO FEDERAL: *Martinez s.n.* (MEXU), in Cetto Garden, Jardines Pedregal near Tizapán, *Moore s.n.* (BH). UNITED STATES. CALIFORNIA: Golden Gate Park, San Francisco, *Walther s.n.* (CAS). IOWA: University of Iowa Experimental Gardens, Iowa City, *Sorensen* 6249 (IA).

After having observed the so-called "tree-dahlias" in their native environment as well as having grown living plants in the gardens and the greenhouses at the University of Iowa, I can find no sound biological basis for maintaining the several taxa into which they have been segregated previously.

Dahlia lehmannii var. *leucantha* was established on the basis of its whitish rather than lavender ligules and its geographic restriction to parts of Costa Rica. Reports from the field (Burger, personal communication, observations of Standley, 1938, and specimen label of *Stork 4722* [GH, MICH,

NY, UC]) indicate that ligule color in wild populations ranges from white to lavender or light purple. This suggests that genetic control of ligule color is most likely multi-factorial, the color-range due to random segregation of quantitative and/or qualitative factors. This same color range has also been observed in populations of *D. merckii, dissecta,* and *scapigera.*

Sherff's (1951 & 1955) recognition of *Dahlia lehmannii* as a separate species from *D. imperialis* stems from the fact that plants on which he based the latter name were from an unusual and widely cultivated horticultural clone.[2] Individuals of this particular clone are, according to Sherff (1955), characterized by excessively drooping heads and smaller ultimate leaf segments (4-7 cm. not 5.5-14 cm. long). I was able to obtain cuttings from what I believe is the same clone mentioned by Sherff (footnote 10, 1951a). During the summer of 1966 these plants were grown alongside wild plants raised from seeds collected in the mountains of Chiapas (*Breedlove* 7424, voucher at DS). By mid-October all of the plants had attained a height of about 5.5 ft. and bore fully developed leaves. At this stage individuals of the two groups were, on the basis of their total morphologic appearance, essentially indistinguishable from each other. Only detailed comparison of them revealed minor differences. For example, the unfolding leaves of the Chiapas plants produced a slight reddish pigmentation which was not seen in the cloned individuals. It was also observed that their mature leaflets were apically more acuminate and less pubescent on the upper surface. Unfortunately these plants were cut down by frost before reaching the flowering stage.

A plant from the cultivated clone which had been planted in the earthen floor (not in a pot) of the "tree-house" at the University of Iowa grew to maturity and flowered. Its heads were seen to be no more pendulous than those on

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[2]Its clonal nature is suggested by the information (Turlington, personal communication,) that "*D. imperialis* has never set seed; it has always been propagated by cuttings or root division."

plants observed in wild populations in Chiapas and Guatemala. As each head on this plant neared the end of anthesis, an apparent abscission layer formed on the peduncle just beneath the head causing the heads to fall. This "flower-drop" is perhaps the result of the heads not having been suitably pollinated considering that this plant is reproductively self-incompatible. Such an hypothesis is, as yet, untested.

Sherff noted that *Dahlia imperialis* (i.e., the cultivated clone) bore leaflets much smaller than the wild "tree-dahlias" (i.e., *D. lehmannii*). I have observed that when these plants are grown in pots in the greenhouse their leaves tend to be smaller than when field grown or when grown in the earthen floor of a tree-house. It is quite likely that Sherff used a greenhouse-grown specimen for his description. He writes (1951b) of having "raised noble specimens of this species [i.e., *D. imperialis* sensu Sherff (1955)] for several years in the greenhouses of the University of Chicago . . . and of the Chicago Teachers College."

In my judgment the cultivated form of *Dahlia imperialis* does not differ sufficiently from the wild plants to warrant treating it as a distinct species. The minor differences displayed in the cultivated Individuals, as compared to those collected in the field, are of no greater magnitude than one finds from plant to plant within a reasonably large wild population in its native environment.

Dahlia imperialis may be distinguished from the other "tree-dahlias" by its 9-15 (not 3-7) primary leaflets. It should perhaps be emphasized that median leaves, or at least a portion of them, are essential in determinations of these species.

3. **Dahlia tenuicaulis** Sorensen sp. nov. TYPE: MEXICO: OAXACA: 13 mi. NE. of village of Ixtlán de Juárez along route 175, Oaxaca-Tuxtepec, in cloud forest, about 9000 ft., 25 Aug. 1965, *Melchert & Sorensen* 6194A (Holotype: IA!, 125,512 & 125,513).

Fig. 2. *Dahlia tenuicaulis* Sorensen. Photograph of type (IA), × 1/3.

Suffrutex, 21-37 dm. altus. Caules lignosi anni praecedentis 1.5-3 cm. diametro. Folia pinnata vel bipinnata, 27-43 cm. longa; foliolis 3-7, pinnis basilaribus 10-18 cm. longis et petiolulis 2-4 cm. longis, marginibus regulatim serratis cum dentibus in quoque latere 8-14. Capitula 12 vel plura in quoque ramo principali, squammis exterioribus involucri reflexis sub anthesi, 8-12 mm. longis, 2-4 mm. latis. Flores ligulati lilacini, 2.8-4 cm. longi, 1-2 cm. lati; flores tubulosi 70-80. Achenia lineari-oblanceolata, 11-15 mm. longa, 1-2 mm. lata. Chromosomatum numerus: $n = 16$. Fig. 2.

Cool cloud forests of *Pinus*, *Abies* and *Arbutus*, deep loamy soil, 8500-10,000 ft., from the type locality in Oaxaca westward on tall peaks to near Santa Monica (about 104° 30′ w. long, 19° 15′ n. lat.), Jalisco. Flowering Aug.-Oct. Map 2.

Map 2. Distribution of *Dahlia tenuicaulis* Sorensen.

MEXICO. MICHOACAN: Cerro Torricillas, *Hinton* 12364 (GH, MICH, NY, US). JALISCO: slopes of Nevado de Colima, *McVaugh* 11745 (MICH), 12926 (MICH), *Melchert et al.* 6396 *A-C* (IA); Cerro de Manantlán, 15-20 mi. SE. of Autlán, *McVaugh* 13873 (MICH); near Santa Monica, *McVaugh* 14110 (MICH). OAXACA: slopes of Cerro San Felipe, *Conzatti & Gonzalez* 552 (GH, MEXU, US), *Conzatti* 2259 (F), *Pringle* 5875 (GH), *C. L. Smith* 295 (F, IA, MO, NY, US);

from 10 to 13 mi. NE. of Ixtlán de Juárez, *Melchert & Sorensen* 6193 (IA); 9 mi. above La Soledad along road to Oaxaca, *Moore* 8247 (BH, MEXU); near K-152 below Suchixtepec, *Moore* 8250 (BH, MEXU); 18 mi. SW. of Oaxaca, *Nelson* 1355 (US); Cerro de Pluma, vicinity of Suchixtepec, *Reko* 3716 (US). GUERRERO: vicinity of Cerro Teotepec, *Hinton* 11083 (GH), 11137 (GH, MICH), *Rzedowski & McVaugh* 163 (MICH); 40 k. W. of Chilpancingo, *Feddema* 2746 (MICH); summit of Sierra Madre near Chilpancingo, *Nelson* 2193 (US); river gorge near Omiltemi, *Sharp* 441534 (F).

Among the "tree-dahlias" *Dahlia tenuicaulis* is the only species endemic in México. It is most easily distinguished from *D. excelsa* and *D. imperialis* by the overall smaller size of its leaves (27-43 cm. not 50-90 cm. long). From *D. imperialis* it is further distinguished by its 1- or 2-pinnate (not 3-pinnate) leaves, by its fewer number of disc florets (70-80 not 120-170) and by its rather slender ligneous stems which barely exceed 2.5 cm. diam. (not 4-10 cm. diam.). There is complete overlap between the species in the size and long-attenuate apices of their leaflets or ultimate segments. In the field it was observed that some individuals of *D. imperialis* produced their current season's growth directly from tuberous roots not exclusively from the previous year's stems as does *D. tenuicaulis*. Unlike *D. imperialis*, which is usually found in open disturbed areas along roadsides and in fields, *D. tenuicaulis* appears to be restricted to dense *Pinus*, *Abies* and *Arbutus* cloud forests at elevations of 8,500 to 10,000 ft.

Section 2. Epiphytum Sherff, Bot. Leafl. 4: 21. 1951.

Type species: *Dahlia macdougallii* Sherff.

Plants epiphytic on tall trees, the stems elongate, solid, ligneous, the roots elongate, aërial, reaching down into the earth. (Species 4.)

4. **Dahlia macdougallii** Sherff, Bot. Leafl. 2: 5. 1950, & Chicago Nat. Hist. Mus. Bull. 22(6): 5-7, *illus.* 1951.

TYPE: MEXICO: OAXACA: about 50 mi. W. of Tehuantepec, 7000-7500 ft., in rain forest above town of Santo Tomás Teipán, Nov. 1949, *MacDougall s.n.* (Holotype: F, sheet number 1,449,390; Isotype: F!).

Perennial, epiphytic on tall trees. Stems solid and woody, about 5 cm. diam., reaching about 10 m. to the tree tops where the flowering branches sprawl for considerable distances. Aërial roots about 5 cm. thick, up to 22 m. long. Uppermost leaves (median or principal leaves not seen) pinnate, 18-27 cm. long; leaflets 3-5, basal pinnae 13-15 cm. long, 4-5 cm. wide, ovate or elliptic-ovate, long-acuminate, the base of principal pinnae at least broadly rounded or almost cordate, sometimes asymmetric bearing a sessile lobe on the proximal side at the base of the main blade; surfaces bicolored, dark green above, gray-green and conspicuously veiny beneath, the upper pubescent along the principal veins and near margins, the lower almost glabrous but with a cluster of brown hairs at the junctions of the main veins; margins ciliolate, the cilia soft and flexuous, antrorsely curved, sharply and regularly serrate-dentate with 15-23 teeth per side; petiole 4.5-10 cm. long, flattened above and rounded below, semicircular in cross-section, essentially glabrous; rachis glabrous; stipels present at median rachis nodes and sometimes at the base of the terminal leaflet when the latter is not decurrent-winged. Heads numerous, at least as many as 14 per main flowering branch, erect or obliquely erect; outer involucral bracts spreading or reflexed at anthesis, 10-14 mm. long, 2-3 mm. wide, lanceolate or rarely oblanceolate, acute or acuminate, dorsally many-lined, glabrous, ventrally appressed pubescent; inner bracts 12-15 mm. long, 3-6 mm. wide; rays white or at least whitish, 4.2-5 cm. long, 1.2-2.2 cm. wide, elliptical or oblong lanceolate, mostly acute at the apex; disc florets yellow; achenes not seen.

I have seen specimens from the type locality only, but Sherff (1951b) states that Thomas MacDougall has observed the species on Cerro Chivato in the territory of the village of San José Quianite which is in the same general area as the type locality. Flowering Nov.

MEXICO. OAXACA: above town of Santo Tomás Teipán, *MacDougall* 21984 (Topotype: NY).

Though not as large, the leaves of *Dahlia macdougallii* bear a strong resemblance to those of the "tree-dahlias." The manner of arrangement of the heads in corymbose clusters at the end of flowering branches is also a feature this species shares with *D. imperialis* and *D. tenuicaulis*. Its unique habit, however, distinguishes it from all other known species.

Sherff (1962) states that some European scientists have been at work on the cytology of *D. macdougallii* but in a

personal communication with him and with the directors of the botanic gardens at Stockholm and Göteborg, Sweden, there is no indication that this work has ever been carried forward.

Section 3. **Entemophyllon** Sorensen, sect. nov. Type species: *Dahlia dissecta* S. Wats.

Herba perennis vel suffrutex, 6-15 dm. alta. Caules numerosis e radicibus tuberosis, plus minusve perennis, lignescentes, 4-20 mm. diametro, caules novi 1.5-12 mm. diametro, saepe cum medulla dissepimenta vel cum dissepimentis incompletis. Folia subtiliter dissecta, pinnati-pinnatisecta vel tripinnati-pinnatisecta cum foliolis oppositis et pinnulis alternis. Squammae exteriores involucri erectae vel ascendentes sub anthesi. Flores ligulati albi, albido-lavanduli vel lilacini, inferne saepe cum macula lutea vel luteo-viridi. Achenia minute tuberculata. Chromosomatum numerus: $n = 17$. (Species 5-9) (see Map 3).

Species 5-9 which comprise the new section Entemophyllon form a coherent evolutionary series within the genus *Dahlia*. Members of this section share a number of characteristics either rare or absent among the other species of the genus.

Cytological information has been gathered for three of the five taxa of this section: *Dahlia dissecta* var. *dissecta*, *D. foeniculifolia*, and the new *D. rupicola*. All have a meiotic chromosome number of $n = 17$, a number not reported previously for the genus (cf. footnote 1). Pairing appears to be completely regular, forming 17 perfect bivalents at diakinesis.

In habit of growth all of the species produce many stems arising from a common tuberously thickened rootstock. This is in marked contrast to the usual single-stemmed (or in section Pseudodendron, 3-4-stemmed) habit of all other species of the genus. The stems of several species in section Entemophyllon live for more than one season becoming quite woody and giving full grown plants a shrubby aspect. Their wood, however, remains rather weak and brittle and the stems rarely exceed 1.5 cm. diam. Pith in the stems of the current season's growth (of all taxa except *D. foeniculifolia* and *D. dissecta* var. *dissecta*) is solid in the early stages

becoming chambered in age or sometimes the diaphragms (about 3 mm. apart) themselves disintegrate leaving behind annular rudiments on the wall of the pith cavity. When crushed or bruised, the herbage of these species emits a particularly strong carroty odor. The segmentation of their leaves is probably the most remarkable characteristic of these species. They all are rather highly dissected (somewhat less so in *D. scapigeroides*) and are at least pinnate-pinnatisect or more often bipinnate to bipinnate-pinnatisect. The primary leaflets are arranged oppositely on the rachis, but the pinnules of the secondary and lesser ranks are arranged alternately on their rachillae. This characteristic is found with the same consistency in just one other species, *D. merckii*.

A rather interesting occurrence attending the circumscription of section Entemophyllon took place while I was preparing for a chromatographic analysis of the secondary biochemical compounds in the leaves of these species. As a first step in this technique, dried leaves were crushed and placed in a flask with acidified methyl alcohol (0.5% or 1% conc. HC1, V:V). After about 12 hours on an orbital shaker the liquid turned milky-green. Upon filtration it was seen that the milky color had been caused by the formation of a water-white, crystalline compound. This precipitate apparently is limited within the genus to the six taxa of section Entemophyllon. The precise nature of the compound remains to be determined, but efforts toward its elucidation are presently in progress.

5. **Dahlia scapigeroides** Sherff, Am. Jour. Bot. 34: 145. 1947. TYPE: MEXICO: HIDALGO: near Ixmiquilpan, Aug. 1905, *Rose, Painter & Rose* 9157 (Holotype: GH!; photo. F!; Isotype: US!).

Dahlia scapigeroides var. *typica* Sherff, Am. Jour. Bot. 34: 145. 1947. Type: as for *Dahlia scapigeroides* Sherff.

Suffruticose perennial reaching 24.5 dm. tall. Stems of the previous season 6-8 mm. diam.; pith chambered or the diaphragms incomplete with only annular rudiments of the septa on the inside wall of the

pith cavity; exterior surface glabrous, pruinose, longitudinally striate, the conspicuous lenticels orbicular or vertically elongate; stems of the current year 5-7 mm. diam., longitudinally striate, glabrous, pruinose; internodes 2-3 cm. long. Leaves pinnate-pinnatisect to bipinnate, 10-16 cm. long, leaflets 5-7, opposite on the rachis, basal pinnae 5-9.5 cm. long, sessile or stalked, petiolules 2-11 mm. long, ultimate segments alternate on the rachilla, 1-2.5 cm. long, 5-16 mm. wide, ovate-lanceolate, acute; surfaces more or less glabrous, occasionally with a few very fine scattered hairs below; margins eciliolate, irregularly and coarsely serrate, 1-4 teeth per side; stipels 0.6-4.5 cm. long, 2-15 mm. wide, ovate, acute, occurring irregularly, when present then only at the junctions of the petiolulate pinnae; petiole 5-7 cm. long, crescent-shaped in cross-section, grooved above; rachis groved above, glabrous except for a cluster of hairs at the junctions with the pinnae. Heads obliquely erect at anthesis, 1-2 per branch on peduncles 9-14 cm. long; outer involucral bracts erect at anthesis, 14-17 mm. long, 5-11 mm. wide, broadly ovate, obtuse, 4-8-lined, the nerves blackish, sometimes faintly reticulate veiny, ventrally puberulent, dorsally glabrous; inner bracts 15-18 mm. long, 6-10 mm. wide; chaff (in fruit) 18-20 mm. long, 5-8 mm. wide; rays lavender or rose-purple, 2.5-4 cm. long, 14-18 mm. wide, ovate, acute or denticulate; disc florets yellow; style branches 2.8-3 mm. long, less than 0.5 mm. wide; achenes 12-15 mm. long, 1.7-2 mm. wide, linear, slightly wider above the middle, longitudinally sulcate, surfaces beset with numerous minute tuberculae; pappus absent or consisting of 2 minute, squarrose rudiments usually less than 1 mm. long.

In dry, rocky places among thorny scrub, 4700-6500 ft., western Hidalgo. Flowering June-Sep. Map 3, open circles.

MEXICO. HIDALGO: cañons, vicinity of Ixmiquilpan, *Purpus* 1341 (F, MO, NY, UC), 5577 (UC); Barranca Grande de Metztitlán, *Moore* 3097 (BH, GH); barranca between Jacala and Tepetates, *Moore* 5036 (BH); near highway SE. of Jacala, *Moore & Wood* 3932 (BH, GH, NY, UC); along road from Zimapán to Mina Lema del Toro, *Moore & Wood* 4407 (BH, GH).

When Sherff (1947) established *Dahlia scapigeroides* and its variety *apiculata* (i.e., *D. apiculata*) he referred to their similarity in growth habit with *D. scapigera*. He noted especially the shortened internodes with leaves crowded near the base of the stem. *D. scapigera*, however, is herbaceous (not suffrutescent) and its current year's growth is from underground tubers, not from ligneous stems of the previous year as in *D. scapigeroides*.

In addition to its woody stems, several other character-

Map 3. Distribution of the species comprising Section 3, Entemophyllon: *Dahlia scapigeroides* Sherff, open circles; *Dahlia foeniculifolia* Sherff, solid diamonds; *Dahlia linearis* Sherff, solid triangle; *Dahlia rupicola* Sorensen, solid squares; *Dahlia dissecta* var. *dissecta*, closed circles; *Dahlia dissecta* var. *sublignosa* Sorensen, stars.

istics of *D. scapigeroides* (e.g. chambered pith, alternate pinnules, a crystalline precipitate in an acidified methanolic extract of its leaves) clearly place it in the section Entemophyllon. It may be distinguished from other members of this section on the following characteristics: from *D. dissecta* vars. and *D. linearis* on the size of its outer involucral bracts (5-11 mm. not 1.8-5 mm. wide); and from *D. foeniculifolia* and *D. rupicola* on the width of its ultimate segments (5-16 mm. not 0.5-2 mm. wide).

6. **Dahlia foeniculifolia** Sherff, Am. Jour. Bot. 38: 70. 1951.
TYPE: MEXICO: NUEVO LEÓN: Dulces, Nombres, open rocky slope, 2000 m., 8 Aug. 1948, *Meyer & Rogers* 2881 (Holotype: US!; Isotypes: F!, GH!, MICH!, MO!, US!).

Herbaceous perennial, producing several canes 14-19 dm. tall from a tuberously thickened rootstock. Stems 5-12 mm. diam., glabrous

except for a cluster of hairs at the nodes, light reddish-brown or purple; internodes 8.5-13.5 cm. long, many-striate. Leaves bipinnate-pinnatisect, 8-33 cm. long (including petiole)[3]; primary leaflets 7-17, the basal pinnae 15-19 cm. long, their pinnules alternate on the rachilla, the ultimate segments narrowly linear 0.5-2 mm. wide, tips long-attenuate, one-nerved, pubescent in the young foliage, mature leaves minutely pubescent or glabrate, green on both sides; margins smooth; petiole from less than 0.5 cm. to 3.5 cm. long; rachis essentially glabrous except for a cluster of hairs at the junction with the pinnae. Heads few, 1-4 per stem, obliquely erect, elevated on peduncles 8-15 cm. long; outer involucral bracts erect at anthesis, ovate to oblong-ovate, 14-18 mm. long, 8-11 mm. wide, conspicuously several to many-purple-lined, the lines running almost to the obtuse or acute tips, dorsally sparingly pubescent or glabrous, ventrally puberulent; inner bracts 15-18 mm. long, 6-9 mm. wide; rays lavender or light reddish-purple, 3.5-6 cm. long, 1.6-2.1 cm. wide, oblong-ovate, acute or denticulate; disc florets yellow, the anthers yellow and long exserted; achenes not seen.

Rocky slopes and ledges, about 6500 ft., Nuevo León and Tamaulipas. Flowering June-Aug. Map 3, solid diamonds.

MEXICO. TAMAULIPAS: 3-5 km. S. of Huitsachél, 6000 ft., *Stanford et al.* 2130 (F, NY, TEX, US).

Dahlia foeniculifolia shares with *D. dissecta* var. *dissecta* its herbaceous habit and the absence of chambered pith. The two are easily distinguished on the dimensions of their outer involucral bracts (14-18 mm. long in the former, 5-7 mm. long in the latter, including also var. *sublignosa*). The outer bracts of *D. foeniculifolia* compare in size to those of *D. scapigeroides* from which it is separated by the much narrower ultimate segments of its leaves (0.5-2 mm. not 5-16 mm. wide) and its herbaceous habit. The highly dissected leaves with very narrow ultimate segments of *D. foeniculifolia* resemble strongly those of the allied *D. rupicola* and *D. linearis*. These species, though apparently both quite closely related to *D. foeniculifolia*, have a suffrutescent growth habit.

7. **Dahlia linearis** Sherff, Bot. Gaz. 89: 364. 1930. TYPE: MEXICO: QUERÉTARO: Querétaro (the exact locality

[3]Only one specimen (*Meyer & Rogers* 2881 at F) has complete median leaves measuring 29-33 cm.; other specimens I have examined possess only leaves from the flowering portion of the stems, these measure 8-15 cm. long.

not given), 1850 m., 1910-1913, *Agniel* 10286 (Holotype: MO!, photo. F!; Isotype: US!).

Suffruticose perennial 8-13 dm. tall, freely branching from tuberously-thickened roots and ligneous stems of the year before. Stems of the previous year 4-8 mm. diam., longitudinally striate, some parts covered with a scaly gray bloom; lenticels conspicuous, vertically oblong, the larger ones 1-2 mm. long; pith chambered; stems of the current year 1.5-5 mm. diam., glabrous, many sulcate, markedly pruinose esp. in the middle portions, the pith solid in younger parts, in older parts becoming chambered; median internodes 3.5-11 cm. long. Principal leaves pinnate-pinnatisect to bipinnate-pinnatisect, 12-18 cm. long; primary leaflets 7-9, their pinnules alternate on the rachilla, the basal pinnae 3.5-9 cm. long; ultimate segments 0.9-2.3 cm. long, their lobes 1-5.5 mm. wide, linear-lanceolate, one-nerved, tips long attenuate-mucronate; surfaces glabrous or with a line of fine hairs along the veins above; stipels usually present on median leaves, attached at the basal and second rachis nodes, 1-5 cm. long; margins smooth; petiole 4-6.7 cm. long, glabrous or with two lines of fine hairs above in the proximal portion; rachis grooved above, minutely hispidulous or glabrous but usually with a cluster of hairs at the junction with the pinnae. Heads obliquely erect at anthesis, usually 2-6 on a stem, on peduncles 1.5-10 cm. long; outer involucral bracts 5-9 mm. long, 2-3.5 mm. wide, oblong-lanceolate, tips acute or subacuminate, dorsally glabrous, green, 4-7 purple-lined, ventrally sparsely pubescent; inner bracts 11-15 mm. long, 4-8 mm. wide, usually glabrous but sometimes with fine hairs near the base; chaff (in fruit) 1012.5 mm. long, 4-6 mm. wide, stramineous with a smudge of yellow near tip; rays purple with a yellow spot at base, 1-2.1 cm. long, 0.9-1.3 cm. wide, ovate, acute or denticulate; disc florets 43-48, yellow, anthers conspicuous; achenes 8-11 mm. long, 1.5-2 mm. wide, linear-oblanceolate, blackish, minutely puberulent and tuberculate, obscurely many-sulcate; pappus obsolete or consisting of 2 erect or squarrose rudiments. Chromosome number, $n = 17$.

Of uncertain extent (the only exact locality being that of *Melchert & Sorensen* 6240 below), on dry ledges and cliffs 5500-6500 ft. in the vicinity of Querétaro City, Querétaro, México. Flowering Aug. Map 3, closed triangle.

MEXICO. QUERETARO: *Arsène* 10083 (US); 5 mi. N. of Ciudad Querétaro along route 57, 150 yds. E. of highway, *Melchert & Sorensen* 6240 (IA).

On the shape and segmentation of its leaves and leaflets *Dahlia linearis* seems closely allied to *D. rupicola* and *D. foeniculifolia*. Its suffrutescent habit distinguishes it from the herbaceous *D. foeniculifolia*. From *D. rupicola*, appar-

ently its closest ally, it separates on such technical features as the size of its outer involucral bracts (5-9 mm. not 10-14 mm. long and 2-3.5 mm. not 4-7 mm. wide), the smaller diam. of its heads (3-4.2 cm. not 5-6.5 cm., including the rays) and the overall dimensions of its median leaves (12-18 cm. not 20-35 cm. long).

8. **Dahlia rupicola** Sorensen, sp. nov. TYPE: MEXICO: DURANGO: 11 mi. W. of La Ciudad along route 40, about 6000 ft., 5 Sep. 1966, *Melchert, Sorensen & Crawford* 6306 (Holotype: IA!).

Suffrutex, 9-15 dm. altus. Caules anni praecedentis lignosi 1.5-2 cm. diametro, lenticellis prominentibus verticaliter elongatis; caules novi 6-11 mm. diametro, glabri (et) pruinosi (que). Folia bipinnati-pinnatisecta, 20-35 cm. longa, foliolis primariis 9-11, tribus paribus inferioribus manifeste petiolulatis, pinnulis alternis, pinnis basilaribus 12-18 cm. longis, libis segmentorum ultimorum 0.6-2 mm. latis, linearibus attenuatis, uninervatis, apice flexuoso-aciculatibus; stipellis 8-12 cm. longis, plerumque (nonnisi) in nodis basilaribus et secundis rachidi affixis. Capitula 2-4; pedunculis 6-11 cm. longis; squamis exterioribus involucri late ovatis, acutis vel acuminatis, erectis vel leviter potentibus sub anthesi, in dorso 5-8-lineatis, marginibus anguste albo-hyalinis, 10-14 mm. longis, 4-7 mm. latis. Flores ligulati lilacini, 2.2-3 cm. longi, 7-11 mm. lati; flores tubulosi 85-109, lobis corollae reflexis sub anthesi. Achenia linearia, dilatata supra medium, 10-12 mm. longa, 1.5-2 mm. lata. Chromosomatum numerus: $n = 17$. Fig. 3.

Abundant along cliffs and rock ledges for a distance of about 8 miles from the type locality westward along route 40, Durango, México. Flowering Sep. Map 3, squares.

MEXICO. DURANGO: 16 mi. W. of La Ciudad, about 15 mi. E. of El Palmito, Sinaloa, 5800-6000 ft., 5 Sep. 1966, *Melchert et al.* 6312 (IA).

Dahlia rupicola is extremely abundant along the main east-west highway through Durango. It is not surprising that it has remained uncollected so long as most of the plants were growing in crevices of exposed cliffs 50-150 ft. above the highway and largely inaccessible either from above or below. When we first encountered this large population of the species we despaired of ever reaching any of the plants, but it was seen that some could be reached from a small ledge midway up the cliff. A cooperative effort with

Fig. 3. *Dahlia rupicola* Sorensen. Photograph of type (IA), × 1/3.

one person doing the climbing and the others with binoculars in hand calling out directions from below finally succeeded. At a station farther along the highway we found a fortuitous landslide had carried down several undamaged plants which we also collected.

With one or more of the species of section Entemophyllon *Dahlia rupicola* shares a shrubby habit, pinnules arranged alternately on the rachilla, finely dissected leaves, a meiotic chromosome number of $n = 17$, and the presence of a white crystalline precipitate in an acidified methanolic extract of its leaves.

Dahlia rupicola most resembles *D. linearis* and *D. foeniculifolia*. These three species all have very finely dissected leaves with rather narrow and long-attenuate ultimate segments. *Dahlia rupicola* is readily distinguished from *D. foeniculifolia* by its woody habit and from *D. linearis*, its closest ally, on such technical features as the dimensions of its outer involucral bracts (10-14 mm. not 5-9 mm. long and 4-7 mm. not 2-3.5 mm. wide), the greater diameter of its heads (5-6.5 cm. not 3-4.2 cm. diam. including the rays) and its larger leaves (20-35 cm. not 12-18 cm. long).

9. **Dahlia dissecta** S. Wats. Proc. Am. Acad. **26**: 141. 1891. TYPE: MEXICO: SAN LUIS POTOSÍ: limestone ledges, San José Pass, July 1890, *Pringle* 3167 (Holotype: US!; Isotypes: F!, GH!, ISC!, MO!, MSC!, NY!, RSA!, UC!, US!).

Freely branching perennial herb, 3-9 dm. tall, a cluster of many herbaceous stems arising from a large, horizontally-elongate ligneous tuber or rootstock, or the current season's stems branching from short (5-15 cm.) woody portions of the previous year's stems. Stems slender, terete, 1.5-4 mm. diam., glabrous, green or reddish-brown when fresh, drying to pale green or tan; internodes 1.5-16 cm. long, the upper solid, the lower hollow, the pith sometimes chambered. Principal leaves pinnate-pinnatisect to bipinnate-pinnatisect, 10-19 cm. long; primary pinnae 5-9, opposite on the rachis, the basal pinnae 2.5-10 cm. long, the pinnules alternate on the rachilla, the ultimate segments 1.0-2.5 cm. long, their lobes 0.5-9 mm. wide, broadest at the base or at the middle and abruptly tapered into a mucronate tip; margins smooth or irregularly short ciliolate, surfaces green on both sides or obscurely lighter green beneath, upper surface glossy when

fresh, glabrous or with very minute hairs along the main veins above; stipels rare or absent; petiole 2-9 cm. long, slightly flattened above; rachis glabrous or with a cluster of hairs at the rachis nodes, usually grooved above, the decurrent bases of the pinnae sometimes forming wings along the margins esp. in the terminal portions of the leaf. Heads in 2's or 3's, obliquely erect (nodding in fruit), peduncles 12-35 cm. long; outer involucral bracts erect or very slightly spreading, 5-7 mm. long, 1.8-5 mm. wide, oblong or ovate, obtuse; inner bracts 9-15 mm. long, 4-7 mm. wide; rays pale lavender to light purple, fading when dry to light or dark tan, 2-4 cm. long, 0.9-1.7 (-2) cm. wide, ovate, acute or denticulate; disc florets about 44, 6-6.5 mm. long, corolla lobes strongly recurved, yellow or yellow with purple tips, sometimes with 5 distinct dark veins; style branches about 3 mm. long, 0.5 mm. or less wide.

In the present treatment two infraspecific taxa of *Dahlia dissecta* are recognized as follows:

9a. **Dahlia dissecta** var. **dissecta**. TYPE: MEXICO: SAN LUIS POTOSÍ: limestone ledges, San José Pass, July 1890, *Pringle* 3167 (Holotype: US!; Isotypes: F!, GH!, ISC!, MO!, MSC!, NY!, RSA!, UC!, US!).

Perennial herb, 3-7.6 dm. tall. Stems 1.5-3 mm. diam.; internodes 1.5-15 cm. long, pith rarely chambered. Leaves 10-15 cm. long; basal pinnae 2.5-5.2 cm. long, ultimate segments 1.0-1.8 cm. long, their lobes 2-9 mm. wide; petiole 2-7 cm. long. Peduncles 12-27 cm. long; outer involucral bracts 5.5-7 mm. long, 1.8-4 mm. wide, ovate, obtuse; inner bracts 9-15 mm. long, 4-6.5 mm. wide; rays 2-3.2 cm. long, 0.9-1.2 cm. wide; achenes narrowly obovate, 9-11 mm. long, 1.5-2 mm. wide, blackish, minutely tuberculate, many-sulcate; pappus absent or consisting of 2 minute rudiments. Chromosome number: $n = 17$.

Rocky slopes and ledges, 6500-8000 ft., Hidalgo and San Luis Potosí. Flowering July-Aug. Map 3, closed circles.

MEXICO. HIDALGO: Distr. of Zimapán, Barranca de San Vincente, *Moore & Wood* 4425 (NY), *Melchert & Sorensen* 6205 A-C (IA), 6213 A-D (IA). SAN LUIS POTOSI: San Juan del Llanos, *Halsted s.n.* (NY); arroya near San Ruizo, *Whiting* 983 (MICH).

The label on an early specimen collected by Halsted (NY) gives the locality as "San Juan del Llanos." Sherff (1955) understood this to be a reference to the town of "Llanos" in northern Puebla, shown on the American Geographic Society's millionth map. I think the small village of San Juan del Llanos in San Luis Potosí (NE. of 22° N. & 100°

Fig. 4. *Dahlia dissecta* var. *sublignosa* Sorensen. Photograph of type (NY), × 1/3.

W.) is the more likely, as this locality would fall well within the known range of *Dahlia dissecta* (see Map 3).

9b. **Dahlia dissecta** S. Wats. var. **sublignosa** Sorensen, var. nov. TYPE: MEXICO: TAMAULIPAS: 3 mi. N. of Miquihuana in pine forest (99°47′ N. Lat., 23°36′ W. Long.), about 7000 ft., 14 July 1949, *Stanford, Rutherford & Northcroft* 2436 (Holotype: NY!; Isotypes: MICH!, TEX!, UC!, US!).

Herba perennis vel subherbacea 7-9 dm. alta. Caules hic annus ramificibus brevi caules (5-15 cm.) longitudinibus anni praecedentis. Folia simulans *Dahlia dissecta* var. *dissecta* autem plus grandis (11-19 cm. longa) et segmentis ultimis plus angustis (0.5-5.5 mm. latis). Pedunculis 12-35 cm. longus; involucri squamis exterioribus erectis vel effusis leviter sub anthesi, 5-7 mm. longis, 2.5-5.5 mm. latis. Flores ligulati diluti-lavanduli ad lilacini, 2.8-4 cm. longi, 1.2-1.7(-2) cm. lati; flores tubulosi flavis, 5-atronervati. Fig. 4.

Known only from the type locality and from an area 0°10′ of long. W. of the type locality, 7000-8000 ft., Tamaulipas, México. Flowering July. Map 3, stars.

MEXICO. TAMAULIPAS: between Marcella and Hermosa, *Stanford et al.* 2436 A (NY, TEX, US).

On morphologic grounds the two infraspecific taxa of *Dahlia dissecta* may be distinguished by the following key:

+Stems of the current year arising from a crown of tuberous roots or rootstock; leaves 10-15 cm. long, ultimate segments 2-9 mm. wide; outer involucral bracts 1.8-4 mm. wide. ..... 9a. *D. dissecta* var. *dissecta*.

+Stems of the current year branching from short (5-15 cm.) ligneous portions of the previous year's growth; leaves 11-19 cm. long, ultimate segments 0.5-5.5 mm. wide; outer involucral bracts 2.5-5.5 mm. wide. ..... 9b. *D. dissecta* var. *sublignosa*.

In addition to the above distinctions it should be pointed out that var. *sublignosa* tends to be generally more robust attaining heights of 7-9 dm. as compared to the height of var. *dissecta* (3-7.6 dm.). There is also a considerable geographic isolation between the two taxa. *Dahlia dissecta* var. *sublignosa* is isolated from the nearest part of the range of var. *dissecta* (at San José Pass in San Luis Potosí) by about 85 miles.

Section 4. **Dahlia.** Type species: *Dahlia pinnata* Cav.
Sect. Neocaulon Sherff, Am. Jour. Bot. 38: 71. 1951.
Type species: *Dahlia coccinea* Cav.

Stems herbaceous (lignescent in *D. apiculata*) mostly with hollow internodes and septate or imperfectly septate nodes; leaves simple to 3-pinnate, pinnules opposite or sub-opposite on the rachilla (alternate on the rachilla in *D. merckii*); petioles solid (hollow in *D. merckii*); outer involucral bracts erect, spreading, or reflexed. Chromosome numbers, $n = 16$, 18, & 32. (Species 10-27.)

10. **Dahlia merckii** Lehm. Del. Sem. Hort. Hamb. 1839; Schlectendal, Linnaea 14(Lit.-Ber.): 130. 1840. TYPE: the original material grown in the Hamburg Bot. Gard. from seeds collected in México, the exact locality not known, *H. J. Merck s.n.* (Lectotype: GH!).

Dahlia glabrata Lindl. in Edwards Bot. Reg. 26: *pl. 29.* 1840. Type: based on plants cultivated in England from seed collected in México, exact locality not known, *G. F. Dickson, Esq. s.n.* Lectotype: *pl. 29*, Lindley, *loc. cit.*

Dahlia cosmaeflora Jacques, Ann. de Flore et Pom. (Jour. des Jard.) 1840: 345, *pl. s.n.* 1840. Lectotype: *pl.* facing p. 345, Jacques, *loc. cit.*

Dahlia decaiseana Verlot, Rev. Hort. 1864: 31, *pl. s.n.* 1864. Lectotype: *pl.* facing p. 31, Verlot, *loc. cit.*

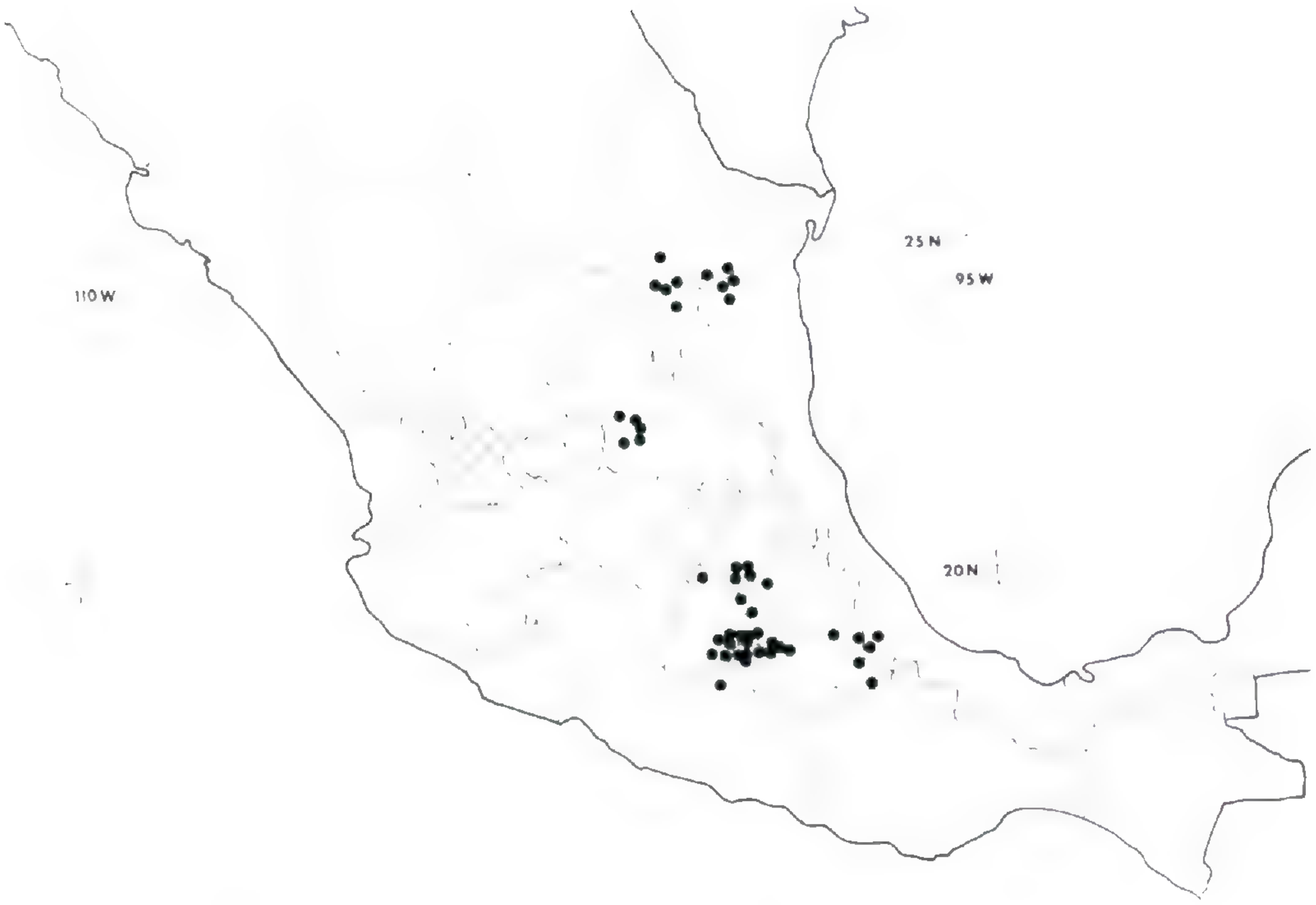
Dahlia scapigera var. *scapigera* f. *merckii* (Lehm.) Sherff, Am. Jour. Bot. **34:** 141. 1947. Type: that of *Dahlia merckii* Lehm.

Herb, 4.5-18.5 dm. tall, freely branching near the base, the leafy portions averaging 1/3 to 1/2 the height of mature flowering plants. Stems 3-9 mm. diam., terete or 6-angled, sometimes strongly 6-ridged (best seen in fresh material), glabrous or sometimes a few hairs gathered at the nodes, usually red when fresh, drying to brownish-red or tan, hollow except for septa at the nodes; internodes 1-27.5 cm. long, the lower often the shortest and usually increasing in length toward the topmost and longest. Leaves once-pinnate to bi-pinnate-pinnatisect, 14-38 cm. long; primary leaflets 5-7, opposite on the rachis (leaflets of the secondary and tertiary ranks alternate on their rachillae), the basal pinnae 6.5-16 cm. long, sessile or stalked, the petiolules or pseudopetiolules 9-40 mm. long; ultimate segments broadly ovate to slightly obovate, 2-5.2 cm. long, 0.9-3.2 cm. wide (the length often about twice the width), the terminal segment usually somewhat larger than its companion segments; apices acute to acuminate; surfaces bicolored, lighter green beneath, the upper glabrous or sparsely pubescent, minutely appressed pubescent along the principal veins, the lower glabrous or sparingly pubescent;

margins ciliolate, the cilia now long, soft and flexuous, now short and rather stiff, irregularly serrate to dentate-crenate, 1-5 teeth per side; stipels usually present, 8-46 mm. long, 3-32 mm. wide, ovate, tips acute or acuminate, attached at each rachis node, except plants from Nuevo León and Tamaulipas on which stipels occur only at the basal rachis node or not at all (stipels sometimes also attached at the basal rachilla node); petiole glabrous, 4-16 cm. long, strongly dilated at the base, when fresh forming a conspicuous fleshy ridge around the stem, medianly terete or hemispherical, hollow; rachis glabrous except for a cluster of hairs at the junction with the primary pinnae, often U-shaped with two parallel ridges above. Heads often numerous, 10-90 per plant (fewer in material from northwest México), obliquely erect or subcernuous, elevated well above the leafy portion of stem on several to many branches, these again branched and terminated by 2-19 heads on peduncles 1-30 cm. long; outer involucral bracts spreading or reflexed at anthesis, linear to slightly spatulate, apically obtuse, 9.5-11.5 mm. long, 1.8-2.2 mm. wide; inner bracts 12-15 mm. long, 5-7 mm. wide; chaff at anthesis hyaline to yellow, sometimes suffused with purple, 4.5-9.5 mm. long, 3-6 mm. wide, enlarging in fruit to 14-18 mm. long, 6-10 mm. wide; rays whitish (said to be white on many labels) to pale lavender to purple, 2-2.9 cm. long, 1.2-2 cm. wide, broadly elliptical, acute or denticulate; disc florets 47-58, corolla yellow, yellow with purple tips or purple, 6-9 mm. long; style branches linear-lanceolate, 2.5-3 mm. long, less than 1 mm. wide; achenes more or less linear, broadest above the middle, abruptly narrowed at the top and capped by a shallow disc, 5.5-10 mm. long, 1.1-2.3 mm. wide, ventrally flattened and dorsally rounded or V-shaped in cross-section, longitudinally sulcate, dark brown to black (tan with dark speckling when immature); pappus absent or consisting of 2 minute rudiments. Chromosome number, $n = 18$.

Rocky slopes, ledges and lava fields ("Pedregales"), 6000-10,500 ft., Nuevo León and Tamaulipas in northern México, south to northern Guerrero, westward from Veracruz to western México state, frequent on cool mountain slopes of Distrito Federal, México state and Morelos. Flowering June-Oct. (Dec.). Map 4.

MEXICO. TAMAULIPAS: E. side of Cerro Linadero, *Meyers & Rogers* 2894 (F, MICH, MO, US); Cañon 4 km. W. of Miquihuana, *Stanford et al.* 767 (F, GH, MO, NY); E. & S. slopes of Cerro Peña Nevada, *Stanford et al.* 2537 (NY, TEX, UC, US); NUEVO LEON: vicinity of Galeana & Cerro Infernillo, *Mueller & Mueller* 837 (F, GH, MICH, TEX), *Taylor* 183 (F, MO, TEX); vicinity of Dulces Nombres, *Meyer & Rogers* 2894 (F, MICH, MO, US), 3009 (F, MICH, MO, US); Cerro Potosí, *McGregor et al.* 296 (MISC); along trail from Trinidad to Cerro de



Map 4. Distribution of *Dahlia merckii* Lehm.

la Cebolla, *Muller* 2879 (GH, MICH, UC); Cerro Grande, *Straw & Forman* 1389 (MICH). SAN LUIS POTOSI: without specific locality, *Parry & Palmer* 477 (GH, ISC, NY, US); slopes of Cerro Alvarez, *McVaugh* 12272 (MICH) *Palmer* 211 (F, GH, MEXU, NY, US), *Pennell* 17831 (MICH, NY); Cerro Aguilla, *Lundell* 5374 (MICH, US); 22 km. W. of Santa Catarina, *Roe & Roe* 2173 (A, WIS). HIDALGO: vicinity of Real del Monte (i.e., Mineral del Monte), *Ehrenberg* 368 (F, GH), *Mexia* 2766 (CAS, MICH, MO, NY, UC), *Martinez s.n.* (F); vicinity of Cerro de Pachuca, *Rose & Hay* 5594 (US), *Rose et al.* 8877 (US); Guerrero near Omitlán, *Martinez* 15048 (MO); along road from Pachuca to Parque Nacional el Chico, *Moore & Wood* 4105 (GH, NY); Cerro Santa Ana, NE. of Apán, *West B*-18 (WIS). VERACRUZ: Loma Grande on Cerro Orizaba, *Balls* 5349 (UC, US); Maltrata at Punta de Zecatál, *Matuda S*-115 (MICH), 1363 (DS, GH, MEXU, MICH, NY, US); 21 mi. W. of Orizaba along route 150, *Melchert & Sorensen* 6200 *A-H* (IA); Cerro Citlaltepetl, *Seaton* 277 (GH), Cambre de Acaltzingo above Orizaba, *L. O. Williams* 13496 (F). PUEBLA: La Cima near Jajalpa, *Kuntze* 23746 (NY), 23747 (NY); Cerro Tepoxuchil, vicinity of Puebla, *Arsène* 1396 (US); Los Chinos, San Manuel de la Sierra, *Balls, B*5306 (UC, US); Puente del Emperador La Venta, *Sharp* 44542 (F); 14 mi. W. of Texmelucan, *King* 3564 (MICH, TEX, UC); above Coxcatlán between Apala and summit of Cerro Chichiltepec, *C. E. Smith et al.* 3817 (F, US); along Tehuacán-Orizaba highway below Puerto del Aire, *C. E. Smith et al.* 3924 (F, MEXU, NY, US).

MEXICO: along route 190 between México City and Puebla, mostly in the vicinity of Río Frío, *Iltis et al.* 1093 (WIS), *Matuda* 21453 (MEXU, NY), *Melchert & Sorensen* 6149 *A-G* (IA), *Rock M*-351 (TEX), *Sharp* 44100 (F), *Sharp & Gilly* 46 (MICH); vicinity of Amecameca along road to summit of Volcán Popocatepetl, *Balls* 5157 (US), *Beaman* 2040 (MEXU, MISC), 2113 (GH, MISC, UC, US), *Purpus* 1553 (POM, UC), *Urbina s.n.* (MEXU); vicinity of Huehuetoca, *Gold & Eheberle* 21770 (MEXU, US), *Matuda* 29070 (MEXU, NY); Mtns. near Guadalupe, *Bourgeau* 802 (or 862) (GH, US); along route 57, México City to San Juan del Río at k-167, *Hawkes et al.* 1395 (F); Cerro de Tranepantla, *Matuda* 21685 (NY); Cerro de Jocotitlán, *Matuda* 31003 (MEXU); 2.5 mi. S. of Tenango along route 55, *Melchert & Sorensen* 6121*A* & 6121-*POP* (IA); 26 mi. W. of México City along route 15, *Melchert & Sorensen* 6238 *A-E* (IA); 55 km. SE. of México City, *Weaver* 743 (GH, US). DISTRITO FEDERAL: on pedregal (lava fields) along route 95 between México City and Cuernavaca, *Clark* 7277 (MO, NY), *Manning & Manning* 531050*A* (GH), *Miranda et al.* 2258 (F, GH, MICH, TEX), *Melchert & Sorensen* 6104 (IA), *Ortenburger et al.* 16*M*732 (F), *Powell & Edmondson* 743 (MICH, TEX), *Rusby* 377 (NY, US); lava fields on the slopes of Cerro Ajusco, *Harshberger* 118 (BH), *Iltis et al.* 143 (WIS), *Matuda* 19169 (MEXU, US), *Rose et al.* 9258 (GH); slopes of Volcán Xitle, *Matuda* 19589 (MEXU, NY). MORELOS: precipitous slopes near Parque Nacional de Zempoala, *Melchert & Sorensen* 6106 (IA), *Ugent & Flores* 1484 (WIS); lava fields above Cuernavaca, *Matuda* 21476 (MEXU, NY), *Pringle* 13039 (CAS, F, GH, MICH, US). GUERRERO; Cuernavaca to Taxco, *Chute M*-90 (MICH).

Sherff (1947, 1955 & 1959) reduced *Dahlia merckii* to the rank of "forma" under *D. scapigera* var. *scapigera*, explaining that this taxon was "best recognized as a somewhat localized color-form [i.e., with purple disc corollas] of *D. scapigera*" (see Table 2). This interpretation was based on his otherwise broad concept of *D. scapigera* (q.v.) proper for which the majority of the specimens he cited possessed yellow disc corollas. I have observed that the purple color of the disc florets mentioned by Lehmann (ex Schlechtendal, 1840) is a localized color-form but one which varies in its intensity and in the amount of the corolla tube so colored from plant to plant within a population. The same sort of variation has been seen in other *Dahlia* species in three of the four sections, notably *D. australis*, *D. scapigera*, *D. imperialis*, and *D. dissecta*.

Aside from its unique chromosome number, $n = 18$, *Dahlia merckii* combines several characteristics which dis-

tinctly set it apart from the remaining species. These are the alternate pinnules, hollow petioles, compact and greatly branched growth of the vegetative portion of the plant, red stems, smooth texture of its leaves, conspicuous stipels, and its large number of flowering heads on compound peduncles. The occurrence of alternate pinnules on the leaves of *D. merckii* could cause confusion with the species of section Entemophyllon, the leaves of which all possess this character. *D. merckii* may be distinguished from them by its hollow petioles and by its spreading or reflexed (not ascending or erect) outer involucral bracts.

11. **Dahlia apiculata** (Sherff) Sorensen, comb. & stat. nov.
TYPE: MEXICO: PUEBLA: Tlanislotepec, 7000-8000 ft., July 1909, *Purpus* 3850 (Holotype: UC!).

Dahlia scapigeroides var. *apiculata* Sherff, Am. Jour. Bot. **34:** 145. 1947. TYPE: that of *Dahlia apiculata.*

Suffruticose perennial. Stems of the previous year solid or hollow, 3-6 mm. diam., purplish-gray, pruinose, glabrous, longitudinally wrinkled, lenticels conspicuous; stems of the current year 2.5-3 mm. diam., solid, longitudinally striate, glabrous except for a cluster of brown hairs at the nodes; median internodes 1-5 cm. long. Leaves once-pinnate, 7.5-14 cm. long; leaflets 5-9, basal pinnae 2.5-4.5 cm. long, 1-2 cm. wide, lanceolate, acute; surfaces glabrous except for a line of minute hairs along the main vein above; margins lacking cilia, sharply serrate with 1-4(-5) apiculate teeth per side; stipels absent; petiole 2-4 cm. long, crescent-shaped in cross-section, puberulent above in the longitudinal groove; rachis glabrous except for a cluster of hairs at the junctions with the pinnae. Heads obliquely erect at anthesis, mostly solitary, sometimes in 2's and 3's, on peduncles 8.5-17 cm. long; outer involucral bracts reflexed at anthesis, 12-17 mm. long, 3-5 mm. wide, oblanceolate, acute, 5-8-lined, usually glabrous, sometimes minutely puberulent on ventral surface; inner bracts 13-20 mm. long, 4-8 mm. wide, ovate-lanceolate, obtuse to subacute; chaff (in fruit) tan, about 20 mm. long, 6-8 mm. wide, ovate, obtuse; rays purple (fide *Purpus* 3112, MO), 3.5-5 cm. long, 2-2.7 cm. wide, ovate, acute or denticulate; disc florets yellow; achenes (immature) 9-10 mm. long, 2-2.2 mm. wide, oblanceolate or spatulate, pappus obsolete or consisting of 2 minute rudiments.

Rocky slopes at 7000-8000 ft. in the vicinity of its type locality near the border of Oaxaca and at about 5000 ft. in the Cañon del Tomellin and Amaloyán, Oaxaca. Flowering May-Dec. Map 5, stars.

MEXICO. PUEBLA: Coscomates and Los Naranjos, vicinity of San Luis Tultitlanapa near border of Oaxaca, *Purpus* 3112 (DS, F, GH, MO, NY, UC, US). OAXACA: Almaloyas [Amaloyán] at Santa Caterina, 1000 m. *Conzatti* 1647 (F); Tomellin Cañon, *Pringle* 5660 (GH, MICH, US); Almaloyán, *Seler* 1395 (GH, MO).

Sherff (1947) first described *Dahlia apiculata* as a variety of *D. scapigeroides*. He presumably based this alliance on such similarities as: (1) their woody habit, (2) their manner of producing short, leafy shoots with the leaves crowded near the base, and (3) their scapose flowering heads. Despite such similarities, however, these taxa are apparently not closely related. In the present treatment, *D. scapigeroides* is allied with the members of the newly created section Entemophyllon. This change is based on a number of characteristics which it shares with the members of that group. With this realignment *D. apiculata* remains the only lignescent member in the section Dahlia.

It may be observed from the list of specimens cited above that *Dahlia apiculata* is known from just two localities. The first is that of the type in Puebla and the other from a location 30 mi. to the south in Oaxaca. Plants collected in each of these geographic areas are seen to be somewhat distinct morphologically. The specimens collected in Oaxaca generally display fewer (3 not 5) and slightly larger (5-8 cm. not 2.5-4.5 cm. long) leaflets than those from the type locality. Both groups do, however, share the suffrutescent habit noted above. Furthermore, the leaves of the two groups are alike in their smooth texture, absence of stipels and eciliolate margins. Additional material of this species with more extensive notes on height, habit, and chromosome number is much to be desired.

12. **Dahlia cardiophylla** Blake & Sherff in Sherff, Field Mus. Publ. Bot. **11:** 453. 1936 (a new name for *Coreopsis cordifolia* Sessé & Moç). TYPE: MEXICO: GUERRERO: mts. of Tixtla, Aug. 1787-1804 (exact date not known), *Sessé, Moçiño, Castillo & Maldonado* 4027 (Holotype: MA, photo. F!).

Coreopsis cordifolia Sessé & Moç. Pl. Nov. Hispan. 147. 1890. & ed. 2. 137. 1893. TYPE: as for *Dahlia cardiophylla* Blake & Sherff

above non *Coreopsis cordifolia* (Schtz.-Bip.) Drake del Cast. Ill. Fl. Ins. Mar. Pacif. 208. 1890; Fl. Polyn. Franc. 109. 1892. which is based on *Bidens cordifolia* Schtz.-Bip. Flora **39:** 361. 1856.
Herb, 7-12 dm. tall, unbranched except in the flowering portions. Stems 3-9 mm. diam., terete, many-sulcate, glabrous, stramineous or green; internodes 5-6.5 cm. long. Leaves simple, sessile and cordate-clasping, their bases slightly connate, 4-8.5 cm. long, 4-8.5 cm. wide; surfaces glabrous throughout, conspicuously bicolored, the upper dark green, the lower glaucous green, the principal veins noticeably stramineous; margins eciliolate, coarsely serrate or dentate with 5-8 teeth per side. Heads solitary or in 2's or 3's, erect or obliquely erect at anthesis, on peduncles 3-6 cm. long; outer involucral bracts reflexed at anthesis, 5-8 mm. long, 2.5-5 mm. wide, broadly obovate or spatulate, obtuse, green, glabrous, dorsally one-several-nerved; inner bracts 1-1.5 cm. long, 4.5-6 mm. wide, greenish-yellow; chaff yellow; rays spreading, 1-1.4 cm. long, 6.5-8 mm. wide, ovate, acute or denticulate, deep purplish-scarlet when fresh, drying to blackish-purple; disc florets yellow; achenes not seen. Chromosome number, $n = 16$.

Precipitous, open or lightly-wooded, rocky slopes, 5500-6000 ft., mts., vicinity of Tixtla, Guerrero, México. Flowering Aug.

MEXICO. GUERRERO: 8 mi. E. of Tixtla along new road to Chilapa at point where road crosses Barranca de Honda, *Melchert & Sorensen* 6142 *A-K* (IA).

Dahlia cardiophylla is a rather rare and interesting species which, until recently, has apparently not been collected, since Sessé *et al.* botanized in México (1787-1804). Its leaves (simple, sessile and cordate-clasping) are quite distinct from any other known species. In only one other species, *D. purpusii*, are the leaves believed to be exclusively simple, but in this species the leaves are rounded or narrowed (not cordate-clasping) at their base, and they are sometimes short petiolate.

13. **Dahlia purpusii** Brandg. Univ. Calif. Publ. Bot. **6:** 76. 1914. TYPE: MEXICO: CHIAPAS: Cerro del Boqueron (now probably Cerro Ovando), Sep. 1913, *Purpus* 6680 (Holotype: UC!; Isotypes: GH!, MO!, NY).

Herb (probably perennial) at least 4 dm. tall. Stems 4-6 mm. diam. many-striate, stramineous, glabrous; internodes 3.5-11 cm. long. Leaves simple, elliptical or almost ovate, short acuminate, base tapered and slightly rounded, 8-12 cm. long, 4-7 cm. wide, sessile or very short petiolate; petiole, if evident, 1-3 mm. long; surfaces glab-

rous, slightly bicolored, salient veiny and lighter green beneath, margins eciliolate, serrate-crenate, 10-18 teeth per side. Heads solitary or in 2's and 3's, erect or obliquely erect on peduncles 5-8.5 cm. long; outer involucral bracts reflexed at anthesis, 8-12 mm. long, 3-4.5 mm. wide, ovate-lanceolate to obovate, acute or obtuse, glabrous, dorsally many-lined and sometimes reticulate veiny; inner bracts 14-15 mm. long, 5-8 mm. wide; rays probably purple, about 3 cm. long, 10-13 mm. wide, ovate, acute or denticulate; disc florets probably yellow; mature achenes not seen.

Known only from the type locality. Flowering September.

Specimens of the type collection of *Dahlia purpusii*, apparently the only ones in existence, are somewhat inadequate. None of the specimens is complete and the labels lack information on the habit of the plants. For these reasons the accompanying description must be considered provisional. Despite the scant material available the validity of this species is not questioned. Its simple leaves are quite unlike those of any other *Dahlia*. The only other simple-leaved species is *D. cardiophylla*, but the leaves of that species are sessile and cordate-clasping (not rounded or narrowed at the base).

14. **Dahlia pinnata** Cav. Icones et Descr. Pl. 1: 57, *t. 80.* 1791. TYPE: exact place of collection and date not known; originally described by Cavanilles from plants cultivated in the Royal Botanic Gardens, Madrid, from seed collected in México and sent to Spain by Vincente Cervantes, ca. 1789 (Lectotype: *t. 80*, Cavanilles, *loc. cit.*[4]).

Georgina purpurea Willd. Linn. Sp. Pl. ed. 4. 3: 2124. 1803. Type: based on *Dahlia pinnata* Cav.

Dahlia sambucifolia Salisb. Parad. Lond. *t. 16.* 1805. Lectotype: *t. 16* in Salisb. loc. cit.

Dahlia pinnata var. *nana* Geo. Jackson in Andrews Bot. Repos. 7: *pl. 483.* 1807. Lectotype: *pl.* 483 in Andrews, *loc. cit.*

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[4]In a personal communication, Dr. J. H. Beaman, Michigan State University, informs me that he made a deliberate search for the type of *D. pinnata* when he visited the herbarium of the Royal Botanic Gardens, Madrid, Spain, in 1963, but was unable to locate it. Types of other species described by Cavanilles were there indicating that had a type been preserved it would have been kept at MA.

Georgina variabilis [var.] *lilacina* Willd. Hort. Berol. 2: *pl. 94*. 1809. Lectotype: *pl. 94*, Willd. *loc. cit.*

Georgina variabilis [var.] *pallida* Willd. *Ibid. pl.* 95. Lectotype: *pl. 95*, Willd. *loc. cit.*

Georgina variabilis [var.] *purpurea* Willd. *Ibid. pl. 93*. Lectotype: *pl. 93*, Willd. *loc. cit.*

Georgina superflua α *rubra* DC. Ann. Mus. Hist. Nat. Paris. **15**: 310. 1810. Type: based on *Georgina variabilis* [var.] *purpurea* Willd. (G-DC, microfiche libraries A-GH).

Georgina superflua β *purpurea* DC. *Ibid.* Type: based on *Dahlia pinnata* Cav. (G-DC, microfiche libraries A-GH).

Georgina superflua γ *lilacina* (Willd.) DC. *Ibid.* Type: based on *Georgina variabilis* [var.] *lilacina* Willd. (G-DC, microfiche libraries A-GH).

Georgina superflua δ *pallida* (Willd.) DC. *Ibid.* Type: based on *Georgina variabilis* [var.] *pallida* Willd. (G-DC, microfiche libraries A-GH).

Georgina superflua ε *flavescens* DC. *Ibid.* 311-312. Lectotype: based on plants obtained from seed of *Georgina superflua* γ *lilacina* (Willd.) DC. (G-DC, microfiche libraries A-GH).

Dahlia purpurea Poir. Lam. Encycl. Suppl. **2**: 444. 1812. Type: based on *Georgina purpurea* Willd.

Dahlia superflua (DC.) Ait. f. Hort. Kew. ed. 2. **5**: 87-88. 1813. Type: based on *Georgina superflua* [vars.] DC.

Coreopsis georgina [var.] *nuda* Cass. Dict. Sci. Nat. **18**: 442. 1820. Type: based on *Georgina superflua* DC. and *Georgina variabilis* [vars.] Willd.

Dahlia variabilis (Willd.) Desf. Cat. Pl. Horti Paris. ed. **3**. 182. 1829. Type: based on *Dahlia pinnata* Cav. and *Georgina variabilis* [vars.] Willd.

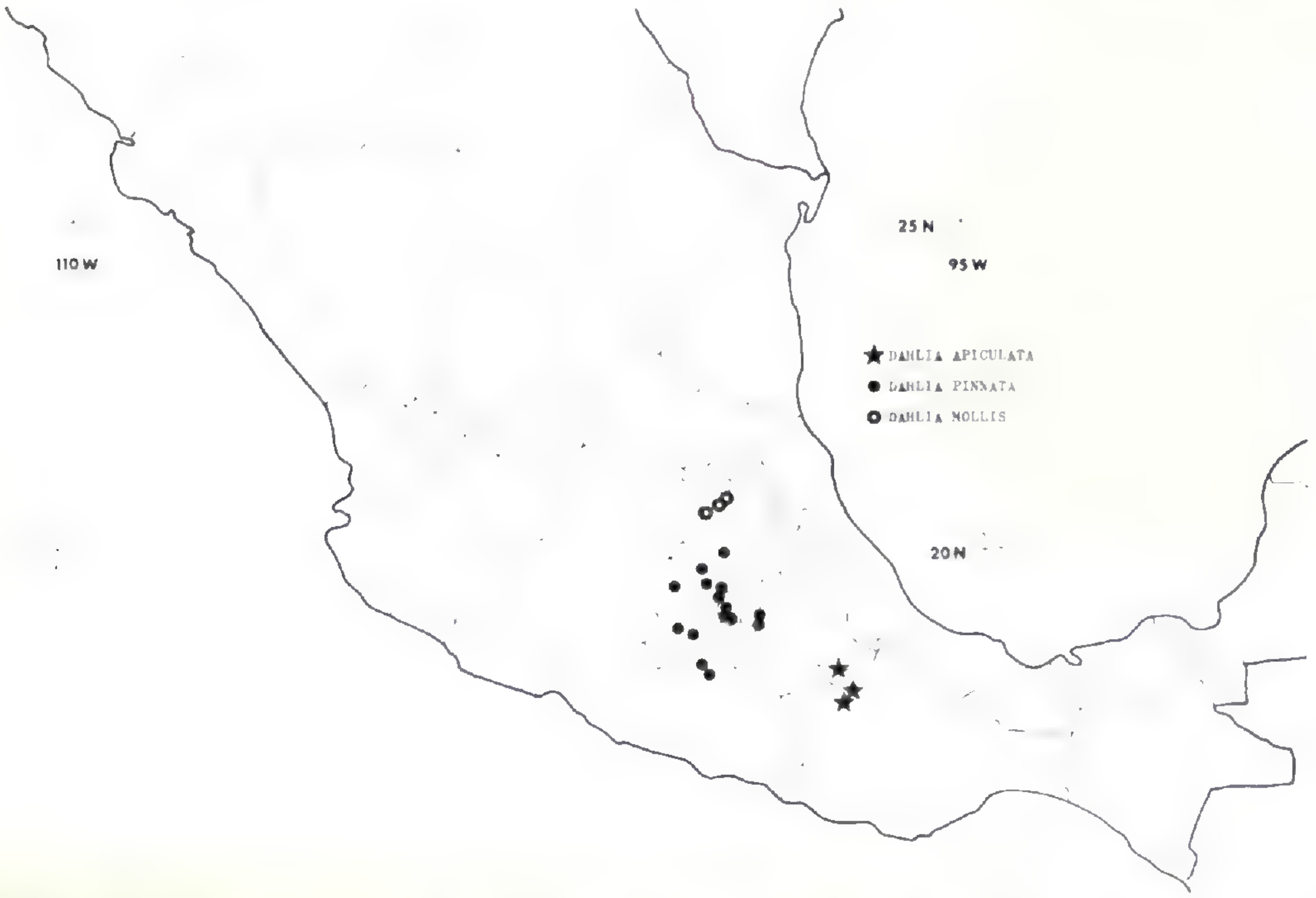
Dahlia pinnata var. *variabilis* (Willd.) Voss in Vilmorin's Blumengart. **1**: 489. 1894. Type: based on *Dahlia pinnata* Cav. and *Georbina variabilis* [vars.] Willd.

Perennial herb, 10-18 dm. tall, usually unbranched except in the flowering portion. Stems 8-12 mm. diam., scabrous, often rather red or maroon; internodes 9-16 cm. long, hollow. Leaves simple or pinnatisect to bipinnate, coarse-textured, 13-25 cm. long; leaflets 3-5, the basal pinnae (or basal segments) 5.5-13 cm. long, 4-8 cm. wide, ovate elliptical, acute; surfaces sparingly pubescent or strigillose, ventrally the hairs short and stiff, esp. along the veins, dorsally the hairs softer, flexuous, following the principal veins; margins ciliolate, the cilia very stiff, coarsely serrate or more commonly dentate, sometimes lacerate; stipels rare, tending to occur with greater regularity on bipinnate leaves; petiole 3.5-12 cm. long, or leaves with a broadly-winged midrib, then pseudopetiolate, often pubescent on the back, broadly crescent-shaped in cross-section; rachis of compound leaves often winged with the decurrent bases of the distal primary pinnae.

Heads few, 2-8 per plant, occurring in 2's ad 3's, erect or obliquely erect at anthesis, on peduncles 5.5-11 cm. long; outer involucral bracts reflexed at anthesis, 10-14 mm. long, 4.5-8 mm. wide, obovate, acute, glabrous, dorsally several-lined; inner bracts 15-21 mm. long, 6-10 mm. wide; rays light-purple or lavender-purple often with a yellowish or rosy spot at the base, spreading, 3.8-4.2 cm. long, 1.7-2.6 cm. wide, ovate, acute or denticulate; chaff resembling the inner bracts, pale yellowish drying to tan; disc florets 96-144, mostly yellow, sometimes with light-purple veins, corolla lobes spreading at anthesis, the tube 9-11 mm. long, style branches 4-5 mm. long, less than 1 mm. wide, linear-lanceolate, long-attenuate; achenes 11-13 mm. long, 2-3 mm. wide, linear-oblanceolate, slightly appressed pubescent near base. Chromosome number, $n = 32$.

Rocky slopes, 7000-10,000 ft., southern Hidalgo south to northern Guerrero, west from the México-Puebla border at Volcán Popocatepetl to western México state, frequent in the volcanic mountains just west and southwest of México City. Flowering May-Nov. Map 5, solid dots.

MEXICO. SAN LUIS POTOSI: chiefly in the region of San Luis Potosí, *Parry & Palmer* 479 (GH, ISC, MO). HIDALGO: vicinity of Cerro de Pachuca, *Miranda* 4454 (MEXU), *Rose et al.* 8784 (US); Cerro de los Pitos, *Matuda* 21542 (MEXU). MEXICO: slopes of Río



Map 5. Distribution of *Dahlia apiculata* (Sherff) Sorensen, stars; *Dahlia pinnata* Cav., *Closed circles;* and *Dahlia mollis* Sorensen, open circles.

Hondo Canyon, *Matuda* 26182 (MEXU, NY), *Pringle* 3165 (F, GH, LCU, MEXU, MICH, MISC, MO, NY, RSA, UC); Amecameca, *Fisher* 197 (F, MO, US); near Huisquilnango, *Matuda* 21092 (MEXU); Cerro Jilotepec, *Matuda* 29121 (MEXU, NY); San Geronimo, Villa del Carbon, *Matuda* 29229 (MEXU, NY, US); Cerro de Azompán, Tequezquinahuac, *Matuda* 31170 (US); 7 mi. S. of Tenancingo along route 55, *Melchert & Sorensen* 6125 *A-D* (IA); about 10 mi. W. of Atlalcomulco near small R.R. station of Bassoco, *Melchert & Sorensen* 6233 *A-E* (IA); about 12 mi. SE. of San Juan del Río along route 57, *Melchart & Sorensen* 6239 *A-B* (IA). DISTRITO FEDERAL: slopes of Cerro de Ajusco, *Pringle* 13546 (CAS, GH, MICH, US), *Pringle* 21556 (US), *Rose & Hay* 5534 (GH, NY, US); Santa Fé, *Bourgeau* 736 (GH, US); at Tizapán (near Villa Obregon), *Bourgeau* 746 (NY); Lomas de Mixcoac, *Lyonnet* 838 (US); Tlalpám, rocky hills, *Russell & Souviron* 32 (US).

Dahlia pinnata is the type species of the genus *Dahlia*. The name was based by Cavanilles on plants under cultivation in Madrid. These as seen by the plate accompanying the original description (Cavanilles, 1791), already had undergone artificial selection for heads producing multiseriate ligules. This fact has led to widespread usage of the name *D. pinnata*, or some nomenclatural equivalent such as *Georgina variabilis* and *Dahlia variabilis*, for any "double-flowered" or otherwise unusual form originating in gardens.

As was the practice in the period, Cavanilles gathered seed from the Dahlia plants in his care (then numbering three species including *D. rosea* and *D. coccinea*) and sent them to various botanists and botanical institutions of Europe with which the Madrid gardens corresponded. Among those receiving seeds were the botanical garden at Montpelier, France, the Museum of Natural History, Paris, Holland House, Kensington, England, and the Royal Botanic Garden, Berlin. Following this distribution, which occurred in the years 1798-1804, Dahlias quickly entered into the horticultural trade throughout Europe. The number of double-flowered and other forms rapidly increased. Concomittant with this was an increase in the number of new names appearing in botanical and horticultural literature. By 1814, fully double-flowered forms had been developed in Louvain, Belgium (Hibberd, 1891), and in 1817,

Breiter listed more than 75 "varieties" in cultivation at Leipzig. The number of garden varieties or cultivars has never ceased to grow. In 1934, Howe (1936) states there were more than 14,000 named cultivars which had been produced in the past or were currently in the trade. All of these numerous horticultural aspects have been consistently equated by authors, from the early 1800's to the present, with the original *Dahlia pinnata*.

There is perhaps little doubt that a trace of the original *Dahlia pinnata* could have been found, were this possible at the time, in the genetic make-up of the many double-flowered Dahlias which arose in Europe during the early 19th Century. In my judgment, however, it is a mistake to name all of these *D. pinnata*. Nor should *any* single species be regarded as the basic one from which these numerous forms were selected. In 1929, Lawrence demonstrated on the basis of biochemical analysis, corroborated by my own findings (cf. discussion following systematic treatment of *Dahlia coccinea*), that the so-called garden Dahlia (designating collectively all Dahlia cultivars), a fertile tetraploid, $n = 32$, was of hybrid origin initially having come from a cross between *D. coccinea* with red or yellow ligules and one of the double-purple-flowered species. Of the two purple-rayed species of the genus known to produced double-flowered forms, *Dahlia pinnata* is the more likely to have been involved in this cross, inasmuch as the other is *D. imperialis*, a diploid, $n = 16$, and one of the "tree-Dahlias" (cf. Popenoe, 1920).

If one recognizes the hybrid nature of the garden Dahlia, the next question to consider is when did the original hybridization occur. Was the *D. pinnata* of Cavanilles already a hybrid at the time of its description, or did the hybridization which led to the subsequent development of the earliest "garden Dahlias" take place after seeds of the original material had been distributed to various botanical institutions in Europe? I am inclined to think the latter was the case. Had the seeds Cavanilles received from

México come from an interspecific cross or from a plant which had been derived previously from such a cross, involving in either case *D. coccinea* as one of the parents, they would have resulted in plants with ligule colors potentially ranging, in different individuals, from white through light and dark purple to yellows, oranges, and scarlets.[5] Yet, the only color Cavanilles (1791) gives for the ligules is purple, "Corolla . . . feminis magna, coeruleo-rubens". (The terms "feminis magna" allude to the pistillate, but sterile, ligulate florets. Only the disc florets are hermaphroditic and fertile.)

The explanation given above for discontinuing the use of *Dahlia pinnata* as the correct name for the garden Dahlia does not solve the problem of naming the many forms now found in cultivation. It would be incorrect to designate the cultivated Dahlias as *D. coccinea* × *pinnata* as has been done often for some taxa known to be the first generation of an inter-specific cross. The development of our modern cultivars has involved repeated hybridization between existing hybrids as well as between hybrids and wild species. Because of this it is best to utilize cultivar names for all those garden forms which are not otherwise clearly selections from among the naturally occurring variants within a wild species population. Unfortunately, at the present time no key to Dahlia cultivars exists. The best means one has to identify cultivars is by making comparisons of his material with portraits and descriptions. To date the most complete list of Dahlia cultivars with descriptions relating to the characteristics of the heads is the booklet entitled *1968 Classification of Dahlias*, compiled and published jointly by the American and Central States Dahlia Societies. In this booklet the names of cultivars are alphabetically arranged within groups based on the diameter of the heads. After each name are symbols

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[5]One usually expects the F_1 to be fairly uniform. Such is not the case in *Dahlia*. The great variability in Dahlia plants is due to the prevailing self-incompatibility which maintains in all progeny a rather high degree of heterozygosity.

which denote the color of the rays and the horticultural category (i.e., whether Formal, Decorative, Pompon, Collarette, etc.). The purpose of this listing is to be able to determine the application of a name by checking the description; however, I have found it practicable to use it for the identification of an unknown by reading through the descriptions within a given group and narrowing the number of possibilities to three or four. Thereafter it becomes necessary to search out portraits for comparison in trade magazines and catalogues.

Dahlia pinnata sensu stricto, is characterized by its rather coarse, often scabrous leaves which vary in their degree of segmentation from simple and unlobed to bipinnate. The petioles, petiolules and rachises are conspicuously winged by the decurrent bases of leaflets and pinnules. The variable margins are often rather coarsely toothed, sometimes lacerate, the teeth usually protruding beyond the outlines of the blades. The variable lobing and segmentation of its leaves are in part due to environmental influence. Plants grown in the greenhouse from wild tubers collected in México (*Melchert & Sorensen* 6125 & 6233) produced simple to pinnate-pinnatifid leaves. Simple leaves developed during winter months (without supplementary illumination) and the pinnate-pinnatifid leaves developed during spring and summer months or during winter months with supplementary illumination.

The geographic range of *Dahlia pinnata* is sympatric with *D. rudis* and *D. atropurpurea*. *Dahlia rudis*, to which *D. pinnata* is closely related, is distinguished by its smooth-textured, flexible (when dry) leaves and by its much larger outer involucral bracts (15-25 mm. not 10-14 mm. long). *Dahlia atropurpurea* is distinguished from *D. pinnata* by the color of its rays which dry to a dark, almost blackish, purple and by its non-winged petiolules and rachises.

To be continued

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REVISION OF THE GENUS DAHLIA (COMPOSITAE, HELIANTHEAE — COREOPSIDINAE)

PAUL D. SORENSEN

(Continued from page 365)

15. **Dahlia pteropoda** Sherff, Am. Jour. Bot. 34: 147. 1947. TYPE: MEXICO: PUEBLA: Cerro del Gavilán, 8000-9000 ft., Aug. 1909, *Purpus* 3851 (Holotype: UC!).

Perennial herb at least 7 dm. tall. Stems about 5 mm. diam., deeply 6-furrowed, more or less pilose, densely so at the nodes, internodes 3.5-7 cm. long. Leaves once-pinnate to bipinnatisect, 13-25 cm. long; leaflets 3-9, elliptical, acute (sometimes abruptly narrowed into the short acuminate tip); basal pinnae 3-8 cm. long, 3-5 cm. wide; surfaces slightly bicolored, ventrally glabrous or essentially so, dorsally pilose; margins densely ciliolate, the cilia rigid and sharp, regularly serrate to dentate-crenate, the undissected pinnae with 8-16 teeth per side; stipels sometimes present at the basal and second rachis nodes, broadly ovate, 15-22 mm. long, 14-18 mm. wide; petiole 4-11 cm. long, 1-4.2 cm. wide, broadly auriculate winged, the wings usually coarsely-toothed, more or less glabrous above, pilose beneath; rachis broadly winged 7-12 cm. wide, glabrous above except at the junction with the pinnae where densely pubescent, pilose beneath. Heads in 2's, sometimes 3's, obliquely erect at anthesis; rays light purple, 22-28 mm. long, 8-14 mm. wide, elliptic-ovate, acute or denticulate; outer involucral bracts reflexed at anthesis, obovate, acute, 8-10 mm. long, 1-2.5 mm. wide, glabrous, dorsally reticulate veiny, the 4-8 main veins parallel; inner bracts 11-14 mm. long, 4-6 mm. wide; disc florets yellow; the immature achenes black spotted, slightly spatulate-linear, almost 9 mm. long, 2 mm. or less wide; pappus obsolete or persisting as 2 minute rudiments.

Known only from southern Puebla, 7000-9000 ft. Flowering August.

MEXICO. PUEBLA: vicinity of San Luis Tultitlanapa, *Purpus* 2536 (GH, UC); Cerro del Gavilán, *Purpus* 3852 (Topotype: UC).

The leaves of *Dahlia pteropoda* with their huge auriculate wings at the base of the petioles are so distinctive there can be no confusion with it and any other known species of the genus. The texture of its leaves suggests a close relationship with *D. pinnata*, an opinion also expressed by Sherff (1947).

16. **Dahlia brevis** Sorensen, nomen nov. TYPE: MEXICO: MÉXICO: on limestone bluffs at Flor de María, Aug. 1890, *Pringle* 3164 (Holotype: US!; Isotypes: F!, GH!, LCU!, MO!, MSC!, NY!, RSA!, UC!).

Dahlia pubescens S. Wats. Proc. Am. Acad. **26**: 142. 1892. Type: based on *Pringle 3164* as above, non *Dahlia pubescens* A. Brongn. ex Neumann, Rev. Hort. II. 4: 305. 1845 (see excluded species).

Dahlia barkerae sensu Sherff, Am. Jour. Bot. **33**: 508. 1946.

Herb 4-7 dm. tall, sparingly branched, growing from very shallow tubers. Stems 2-5 mm. diam., many-striate, pubescent, increasingly hairy at the nodes; median internodes 4-8 cm. long. Leaves sometimes simple but more commonly once-pinnate or once-pinnatisect, rarely bipinnatisect, 3.5-14 cm. long; leaflets or divisions 5-7(-9), opposite, rarely sub-opposite or alternate; the basal pinnae 12-40 mm. long, 4-12 mm. wide, oblong-lanceolate, acute or subacute to almost obtuse; the terminal leaflet or segment smaller than its companions; surfaces light-green or obscurely bicolored, ventrally glabrous or sparingly pubescent, dorsally conspicuously pubescent, especially along the principal veins; margins ciliolate, the cilia very short, stiff and almost cartilaginous, antrorsely curved, entire or irregularly serrate with 1 or 2 teeth per side; stipels absent; petiole 7-22 mm. long, 0.5-4 mm. wide, usually winged from the decurrent bases of its lateral divisions, base of petiole often beset with long, broad-based, multicellular hairs; rachis winged, pubescent, especially at the junction with the leaflets. Heads 1-3, rarely 4-6, per plant, obliquely erect at anthesis, on peduncles 10-24 cm. long; outer involucral bracts erect at anthesis, 6-9 mm. long, 2.5-3 mm. wide, broadly obovate, obtuse, conspicuously purple striate with 5-9 parallel veins; inner bracts 10-14 mm. long, 4-7 mm. wide, conspicuously many purple-lined; rays light purple, spreading at anthesis, 10-25 mm. long, 6-14 mm. wide, elliptical, acute or denticulate; disc florets yellow, corolla with purple veins, lobes purple margined or entirely purple; chaff (in fruit) 12-13 mm. long, 7 mm. wide; achenes 6-7 mm. long, 2-3 mm. wide, broadly spatulate, minutely puberulent; pappus obsolete or consisting of 2 minute tubercles. Chromosome number, $n = 16$.

Moist rocky slopes and rocky ledges, 8500-10,000 ft., northwest México state. Flowering Aug.-Sep.

MEXICO. MÉXICO: At K-167 near Calpulalpan on route 57, México City to San Juan del Río, 3100 m., *Hawkes et al.* 1396 (F); about 10 mi. W. of Atlacomulco at Estación Bassoco along gravel road to El Oro, 9000 ft., *Melchert & Sorensen* 6235 *A-E* (IA).

The present species was first described by Watson (1891) who chose for it the name *Dahlia pubescens*. It is now clear that the name *D. pubescens* is a later homonym and for this reason I have given the species the new name *D. brevis* alluding to its diminutive habit.

As is evident in the list of synonyms above, the name *Dahlia barkerae* sensu Sherff (1946, 1955, 1962, 1966) was used with reference to this species. It is clear from the materials at hand and from my observations of living plants both in the field and in cultivation that such usage was incorrect. The name *D. barkerae* Knowles & Westcott is correctly referable to the taxon which Sherff (1946) had described as the new variety *D. scapigera* var. *arsenei* (see table 2).

On the texture, color and shape of its leaves, *Dahlia brevis* strongly resembles a dwarfed *D. pinnata* sensu stricto. *D. pinnata* may be distinguished by its greater height, outer involucral bracts reflexed at anthesis, larger leaves, larger heads and chromosome number of $n = 32$.

Several specimens of *D. brevis* I have examined were previously identified as species of *Cosmos* and vice versa. *Cosmos* species are, however, easily distinguished by the tufts of hairs on their filaments and their 4-angled (not obcompressed) achenes.

17. **Dahlia rudis** Sorensen, sp. nov. TYPE: MEXICO: DISTRITO FEDERAL: Salazar (a railroad station SW. of Mexico City), 2800 m., Sep. 1941, *Lyonnet* 3372 Holotype: US!).

Herba parennis, 9-30 dm. alta. Folia plerumque pinnata, interdum bipinnata, 16-25 cm. longa; foliolis sessilibus vel petiolulatis 9-25 mm. longa; pinnis basilaribus 11-15 cm. longis, 2.5-5 cm. latis, foliolis ter-

Plate 1419

Fig. 5. *Dahlia rudis* Sorensen. Photograph of type (US), × 1/3.

minalibus ovato-lanceolatis, longo-acuminatis vel attenuatis; nervo medio dorsaliter stramineo; marginibus regulatim serratis cum dentibus in quoque latere 10-16; stipellis in rachidis nodis basilaribus et interdum secundis affixis; petiolo valde lunato in sectione transversale, alato saepe pinnis basilaribus decurrentibus, basi valde amplexicaule praesertim ad apicem plantae. Capitula solitaria vel in binis vel trinis, pedunculis 7-16 cm. longis; involucri squamis exterioribus reflexis sub anthesi, 15-25 mm. longis, 4-10 mm. latis, dorsaliter 6-10-nervis, interdum intervenium reticulatis. Flores ligulati lilacini, 2-3 cm. longi, 1-1.5 cm. lati. Fig. 5.

In high mountains, 8600-10,000 ft., from near Amecameca in eastern México state westward in northern Morelos, Distrito Federal, and to the vicinity of Temascaltepec, southwestern México state. Flowering Aug.-Oct.

MEXICO. HIDALGO: 10 km. NNE of Apam, *West* H-5 (WIS). MEXICO: Distr. of Temascaltepec, *Hinton* 1885 (MO, US), 8332 (GH, US); Amecameca, *Kuntz* 23660 (NY); Criadero, *Matuda* 19411 (MEXU, US); W. of Transfiguración, *Russell & Souviron* 215 (US); Cerro del Pueblo de Hoacalco de Cuautitlán, *Salasar s.n.* (MEXU). MORELOS: Lago Zempoala, *Matuda* 25575 (MEXU, NY); from cultivation: UNITED STATES. CALIFORNIA: grown from Mexican seed at Golden Gate Park, *Walther s.n.* (CAS).

Among the specimens of *Dahlia rudis* cited above only two have labels providing information on the height of the plants (3 ft. & 3 m.), only one gives its habit (herb) and none provide what appear to be median leaves. The accompanying description must, therefore, be considered provisional.

Certain characteristics of *Dahlia rudis* suggest a relationship to the "tree-dahlias," the leaflets with long attenuate apices and tan colored midveins on the undersurface and the large, often reticulately-veined, outer involucral bracts. Several of the specimens have, in fact, been identified with names of "tree-dahlias" as *D. maximiliana*, and *D. excelsa*.

Dahlia rudis is distinguished by its conspicuous sheathing petioles (of the upper leaves) and its very large outer bracts. Most specimens show relatively few heads per branch (2-4) but one, at least, shows several more buds rather close to anthesis.

18. **Dahlia moorei** Sherff, Bot. Leafl. 5: 22. 1951. TYPE: MEXICO: HIDALGO: near K-238 along route 85, limestone ledges and streamside thickets, Barranca de San Vicente, 1800-2000 m., 24 Sep. 1941, *H. E. Moore* 5068 (Holotype: F!; Isotypes: BH!, GH!, UC!).

Herb 18-25 dm. tall. Stem 5-8 mm. diam, drying to reddish-brown or tan, many-striate, glabrous; internodes 12-21 cm. long, hollow. Leaves bipinnate, 20-30 cm. long; leaflets 5-9, the basal pinnae 14-17 cm. long, sessile or stalked, the petiolules 12-30 mm. long; ultimate segments opposite or alternate on the rachilla, 3.5-7 cm. long, 1.5-2.3 cm. wide, ovate-lanceolate, apices long-attenuate or flagelliform; surfaces slightly bicolored, lighter green beneath, ventrally pubescent, the hairs occurring between the veins, dorsally puberulent, the hairs following the veins; margins ciliolate, the cilia slender and flexuous, coarsely and regularly serrate, the terminal leaflet with 10-18 teeth per side; stipels present at the basal and second nodes on the rachis, 1.5-4 cm. long, 0.8-2 cm. wide; petiole 2-12 cm. long, glabrous, crescent-shaped in cross-section, longitudinally grooved above; rachis glabrous except at the junction with the pinnae. Heads subnumerous, 6-12 per main branch, obliquely erect, on peduncles 4.5-16 cm. long; outer involucral bracts reflexed at anthesis, 10-17 mm. long, 1.5-4 mm. wide (near the base), linear-lanceolate, becoming long-attenuate or flagelliform, glabrous, dorsally 5-8-lined, ventrally sometimes strongly cross-wrinkled; inner bracts 13-15 mm. long, 4-7 mm. wide; rays deep rose-purple, 2-2.6 cm. long, 10-14 mm. wide, elliptical, acute or denticulate; disc florets yellow below, purple above; style branches purple; anthers yellow with purple veins; achenes linear-spatulate, glabrous or puberulous, many-sulcate, 6.5-7 mm. long, 1.3-1.6 mm. wide, constricted slightly below the summit to form a black disc less than 1 mm. wide and barely 0.4 mm. high, pappus obsolete or consisting of 2 minute rudiments.

Known only from the type locality in the Barranca de San Vicente, Hidalgo. Flowering Aug.

MEXICO. HIDALGO: Near K-238 along route 85, Barranca de San Vincente between Zimapán & Jacala, *Moore & Wood* 4441 (Topotypes: A, BH, NY, UC, WIS).

Certain floral characteristics found in *Dahlia moorei* such as the purple style branches and the thickened, black apical achenial disc are unique among the dahlias. Its long-attenuate, almost flagelliform outer involucral bracts are like those of *D. hintonii* but in that species the bracts are dorsally pilose, not glabrous. The leaves of *D. moorei,* with

ovate-lanceolate leaflets, their apices long acuminate and margins evenly serrate, resemble those of *D. rudis* from which it is distinguished by its flagelliform (not broadly obovate or oblanceolate) outer bracts and its large number of heads (6-12 not 1-4) per branch.

19. **Dahlia hintonii** Sherff, Am. Jour. Bot. 34: 138. 1947.

TYPE: MEXICO: GUERRERO: Distrito de Minas, Toro Muerto, on boulder in pine forest, 2150 m., 27 July 1939, *Hinton et al.* 14499 (Holotype: GH!; Isotypes: MICH!, NY!, UC!, US!).

Herb 10-15 dm. tall. Stems unusually slender, 2 mm. or less diam., tan, glabrous or a few soft hairs at nodes. Sub-median[6] leaves petiolate, once-pinnate, 11-17 cm. long; leaflets 3-5, basal pinnae 5-8.5 cm. long, 1-2 cm. wide, lanceolate, becoming long-acuminate or attenuate; surfaces slightly bicolored, dorsally lighter green, the upper glabrous or essentially so, the lower densely pilose; margins finely ciliolate, the cilia antrorsely curved, regularly or irregularly serrate, 3-7 teeth per side; stipels absent; petiole 1-3 cm. long, puberulent, crescent-shaped in cross section, grooved above; rachis pubescent, increasingly so at the junction with the primary pinnae. Heads 4-8 per branch, erect or obliquely erect; outer involucral bracts linear or slightly linear-spatulate, reflexed at anthesis, 11-20 mm. long, 1-2 mm. wide, dorsally pilose, ventrally pubescent, becoming almost glabrous near tips; inner bracts 13-16 mm. long, 4.5-7 mm. wide, pubescent in the middle, glabrous toward margins; rays ovate, acute or denticulate, 13-18 mm. long, 8-10 mm. wide, said to be purple; disc florets yellow with lobes of the corolla dark; achenes not seen.

Known only from the type locality in south-central Guerrero, just west of Cerro Teotepec. Flowering July.

Certain distinctive characteristics of *Dahlia hintonii* are unique in the genus. Its once-pinnate leaves are composed of unusually narrow, lanceolate leaflets 3-5 times longer than wide and its rather long and slender outer involucral bracts are minutely but densely pubescent.

20. **Dahlia mollis** Sorensen, sp. nov. TYPE: MEXICO: HIDALGO: 12 mi. S. of Jacala, 1 m. S. of Minas Viejas, along route 85, about 7800 ft., 30 Aug. 1965, *Melchert & Sorensen* 6209 (Holotype: IA!).

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[6]No median leaves present on *Hinton* 14499.

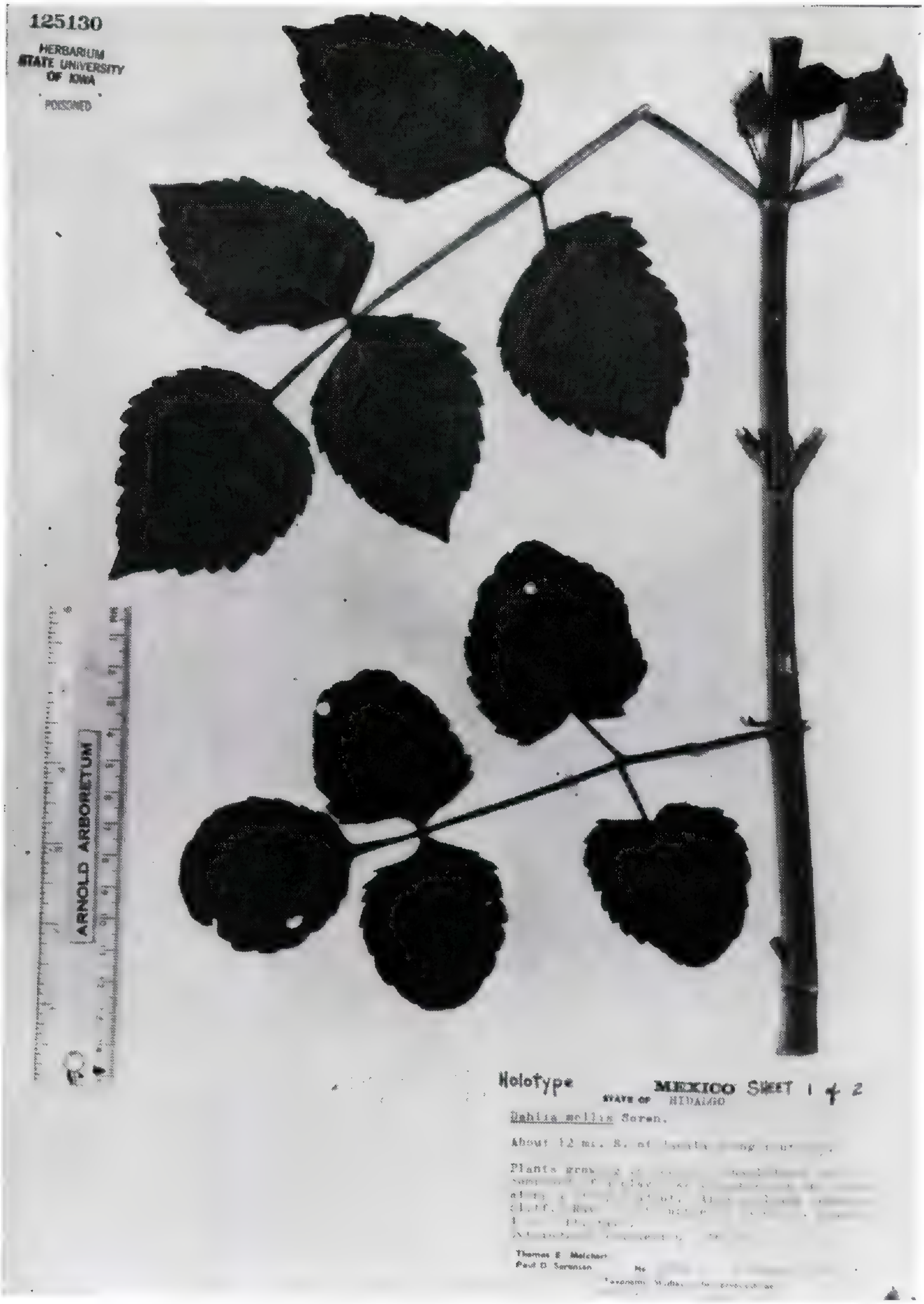


Plate 1420

Fig. 6. *Dahlia mollis* Sorensen. Photograph of type (IA), × 1/3.

Herba perennis, 10-16 dm. alta. Caules omnino dense pubescentibus, nodis copiose pilos. Folia pinnati, 13-29 cm. longi, foliolis 3-5, pinni basilaribus 4-11 cm. longis, 3.5-5 cm. latis, late ovatis, apice acutis, basi contractis vel rotundatis (foliolis terminalis interdum basi truncatis vel subcordatis), ventraliter pubescentibus, pili brevis, dorsaliter subtomentosis; marginibus dense et conspicue ciliatis, serrato-crenatis, dentibus, in quoque latere 7-12; stipellis absentibus; rhachi et petiolo pubescentibus, nodis rhacheos floccosis. Capitula in binis vel trinis, pedunculis glabris, 3.5-14 cm. longis; involucri squamis exterioribus effusis vel reflexis sub anthesi, 7-11.5 mm. longis, 3-3.6 mm. latis, dorsaliter 5-9 nervis, glabris. Flores ligulati lilacini, 2.7-3.5 cm. longi, 12-18 mm. lati. Chromosomatum numerus: n = 16. Fig. 6.

Rocky slopes and ledges, 7800-8400 ft., western Hidalgo, México. Flowering Aug.-Sep. Map 5, open circles.

MEXICO. HIDALGO: 13 to 14 mi. S. of Jacala, 2 mi. S. of Minas Viejas along route 85, 8000 ft., *Melchert & Sorensen* 6210 *A-C* (IA), *Melchert et al.* 6504 (IA); trail from Zimapán to mines of El Monte, 7800-8400 ft., *Moore & Wood* 4469 (BH).

The most distinctive feature of *Dahlia mollis* is the dense pubescence of the dorsal leaf surface. Only one other species in the genus, *D. hintonii*, has leaves that are as velvety and soft to the touch. The shape and size of the leaflets of the two are quite distinct, those of *D. hintonii* being narrowly lanceolate and smaller.

The shape and size of the leaves of *Dahlia mollis* resemble those of *D. barkerae*, but in that species the upper surface is dark, glossy green and rugose and the lower surface is not nearly so tomentose. Furthermore, plants of *D. barkerae* are much smaller (3-7 dm. tall) and have a higher chromosome number ($n = 32$).

21. **Dahlia atropurpurea** Sorensen, sp. nov. TYPE: MEXICO: MÉXICO: 4 mi. SE. of Sultepec on Cerro Cualtepec, about 8500 ft., 27 Sep. 1966, *Melchert, Sorensen & Crawford* 6498 (Holotype: IA!).

Herba perennis, 15-22 dm. alta. Folia pinnata ad bipinnata, 16-25 cm. longa; foliolis primariis 5-7, pinnis basilaribus ovato-lanceolatis, 6-13 cm. longis, 2.3-3.8 cm. latis, petiolulatis 1.3-3 cm. longis, apice longo-acuminatis, basi rotundatis; paginis bicoloribus, dorsaliter pallido-viridibus vel cano-viridibus, parce pubescentibus, praesertim ad nervos, ventraliter glabris, rugosis; marginibus serrato-crenatis,

dentibus in quoque latere 6-10; petiolis 2.4-5.5 cm. longis; stipellis nodis in basilibus et medianibus rhachidibus affixis. Pedunculis 6.5-11 cm. longis; exterioribus involucri squamis reflexis sub anthesi, 5-9.5 mm. longis, 3-5 mm. latis, dorsaliter et nervis purpureis 5-9, glabris, ventraliter parce adpresso-pubescentibus vel glabris. Flores ligulati atropurpurei vel atropurpureo-nigri, 2.2-3.5 cm. longi; flores tubulosi lutei vel lutei cum apicibus purpureis. Chromosomatum numerus: $n = 32$. Fig. 7.

Known only from the type locality, about 8500 ft., on Cerro Cualtepec near Sultepec, México state and from near Chiriagua, Distr. of Minas, Guerrero. Flowering Sep.

MEXICO. GUERRERO: Chiriagua, distr. of Minas, 2140 m., *Hinton et al.* 10665 (GH).

Several characteristics of *Dahlia atropurpurea* distinguish it from other species or species complexes in *Dahlia*. Its rays, which dry to a dark, almost blackish purple, are not found in any other of the purple-rayed species except *D. cardiophylla* from which it is easily separated by its compound (not simple) leaves.

Dahlia atropurpurea is sympatric with *D. pinnata* and *D. rudis*, two species with which it might possibly be confused. Each of these species is distinguished by its leaf characteristics. The leaves of *D. atropurpurea* are characterized by: (1) drying to a firm and smooth (not coarse nor scabrous) texture, (2) the absence of wings on the rachis, petiole, and petiolules, (3) the 6-10 teeth per margin and (4) the rounded (not attenuate-narrowed) bases of the petiolulate leaflets. The rather coarse-textured, sometimes scabrous leaves of *D. pinnata* are winged, often strongly so, on the rachis, petiole and petiolules and their leaflet bases are attenuate-narrowed. The leaves of *D. rudis* dry to a smooth texture but are rather flexible and thin and their leaflets are attenuate-narrowed at the base and have 10-16 teeth per margin. *D. rudis* is further distinguished from *D. atropurpurea* by its larger outer involucral bracts (15-25 mm. not 5-9.5 mm. long).

On leaf dimensions and segmentation there is considerable overlap between *D. atropurpurea* and the *D. australis-sherffii* species complex. In addition to their geographic

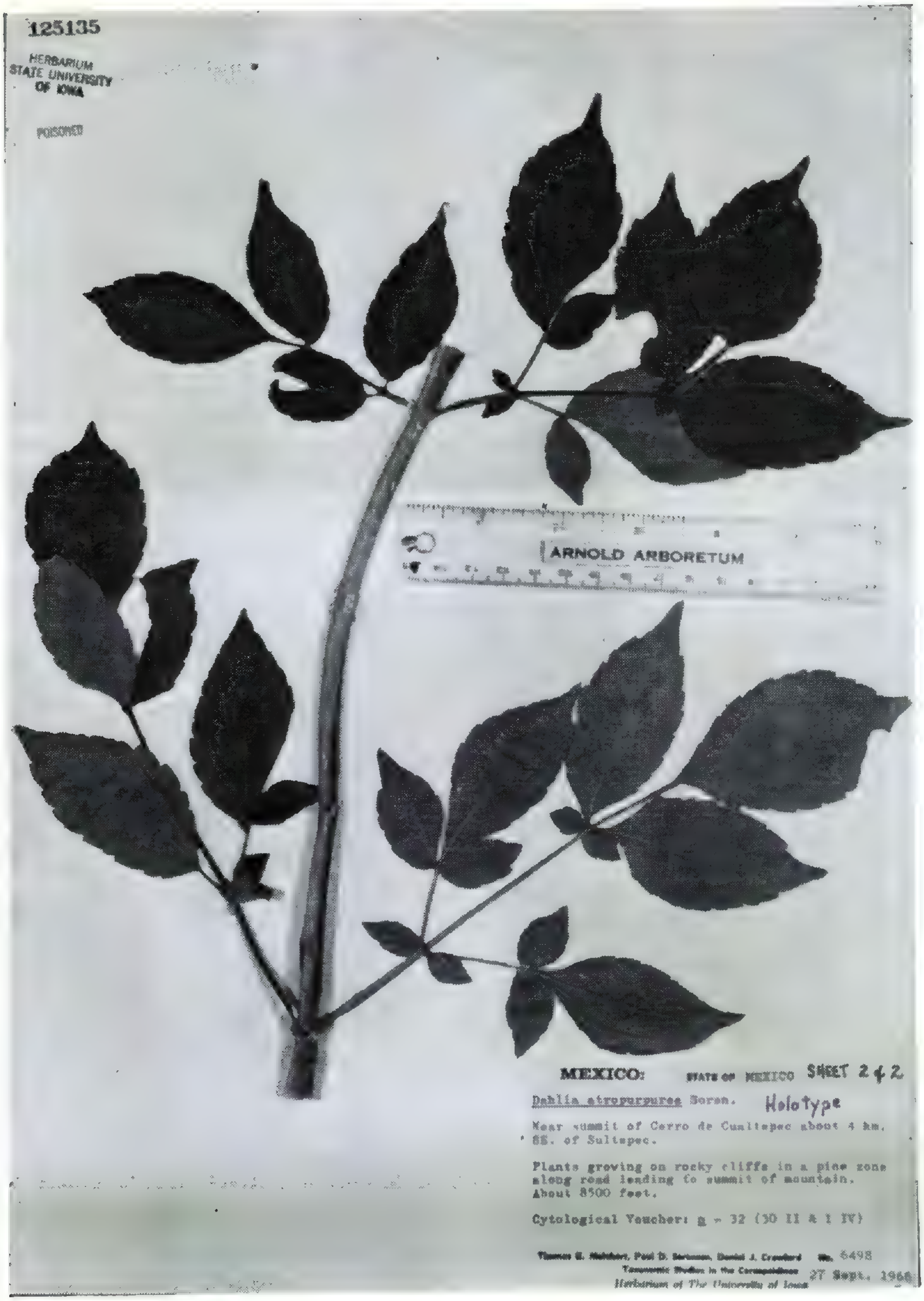


Plate 1421

Fig. 7. *Dahlia atropurpurea* Sorensen. Photograph of type (IA), × 1/3.

distinctions the latter species are best distinguished on the nature of their attentuate-narrowed (not rounded) leaf bases.

22. **Dahlia australis** (Sherff) Sorensen, comb. & stat. nov.

TYPE: MEXICO: OAXACA: Cerro de San Felipe, 2500 m., 1 Sep. 1897. *Conzatti & Gonzales* 543 (Holotype: GH!).

Herbaceous perennial, 4.6-12.3 dm. tall, branching freely or unbranched except in the flowering portion. Stem 2-6 mm. diam., essentially glabrous to conspicuously pubescent, sometimes scabrous on the lower portions, hairs becoming dense at the nodes; internodes 3.5-24(-28.5) cm. long, hollow or sometimes solid. Leaves usually once-pinnate but ranging from merely pinnatifid to bipinnate, 3-21 cm. long; primary leaflets 3-5(-7), basal pinnae 1.5-9.5 cm. long, ultimate segments oblong or rhombic-ovate to ovate-lanceolate, apex acute or acuminate, base attenuate-narrowed, sessile or stalked, petiolule 1-13 mm. long, terminal leaflet often 3-lobed, sessile or pseudopetiolulate; surfaces usually bicolored, green or dark green above, gray or silvery-green and salient veiny beneath, the upper rugose, glabrous or with a few scattered hairs near the margins and apex, often with a line of fine hairs along the principal veins, the lower usually pubescent esp. along the veins; margins ciliolate, regularly or irregularly serrate to crenate-dentate with 2-10 teeth per side, slightly revolute; stipels usually present, attached at the basal (rarely also at the second or median) rachis node; petiole 0.9-10 cm. long, sometimes very slightly winged in the distal parts, grooved above and crescent-shaped in cross-section, almost glabrous to noticeably pubescent; rachis usually narrowly winged, glabrous or pubescent, the hairs becoming dense at the junction with the primary pinnae. Heads solitary or in 2's and 3's, erect or obliquely erect; outer involucral bracts reflexed at anthesis, 7-15 mm. long, 1.5-6 mm. wide, linear-oblanceolate to oblong-spatulate or obovate, dorsally glabrous, 4-8-lined, ventrally sometimes minutely appressed pubescent; inner bracts 10-18 mm. long, 3-9 mm. wide, brownish or sometimes suffused with purple at the tips, rarely purple throughout; rays purple; chaff resembling inner bracts; disc florets 39-67, 6-9 mm. long, the limb ranging from yellow throughout to purple throughout with many intermediates, corolla lobes often reflexed or revolute at anthesis; style branches long attenuate, 2.5-3.2 mm. long, less than 0.8 mm. wide; achenes (derived from greenhouse plants) 7-11.4 mm. long, 2-3 mm. wide, linear-oblanceolate to obovate, blackish or speckled gray; pappus obsolete or consisting of 2 minute rudiments. Chromosome numbers, $n = 16$ & 32.

As treated here *Dahlia australis* (Sherff) Sorensen is composed of four infraspecific taxa as outlined and described below. These are var. *australis*, var. *chiapensis*, var. *serratior*, and var. *liebmannii* (see Table 2). Each of these is geographically isolated (see Map 6) and, to a limited extent, morphologically distinct. Excepting var. *liebmannii*, a little-known taxon marked by its rather small leaves and short petioles, none of the varieties is easily distinguished on any single morphologic feature. Their distinguishing characteristics are primarily of a quantitative nature and are discussed in turn following the taxonomic treatments of each variety. For the convenience of the user, the following key to the infraspecific taxa of *Dahlia australis* is provided.

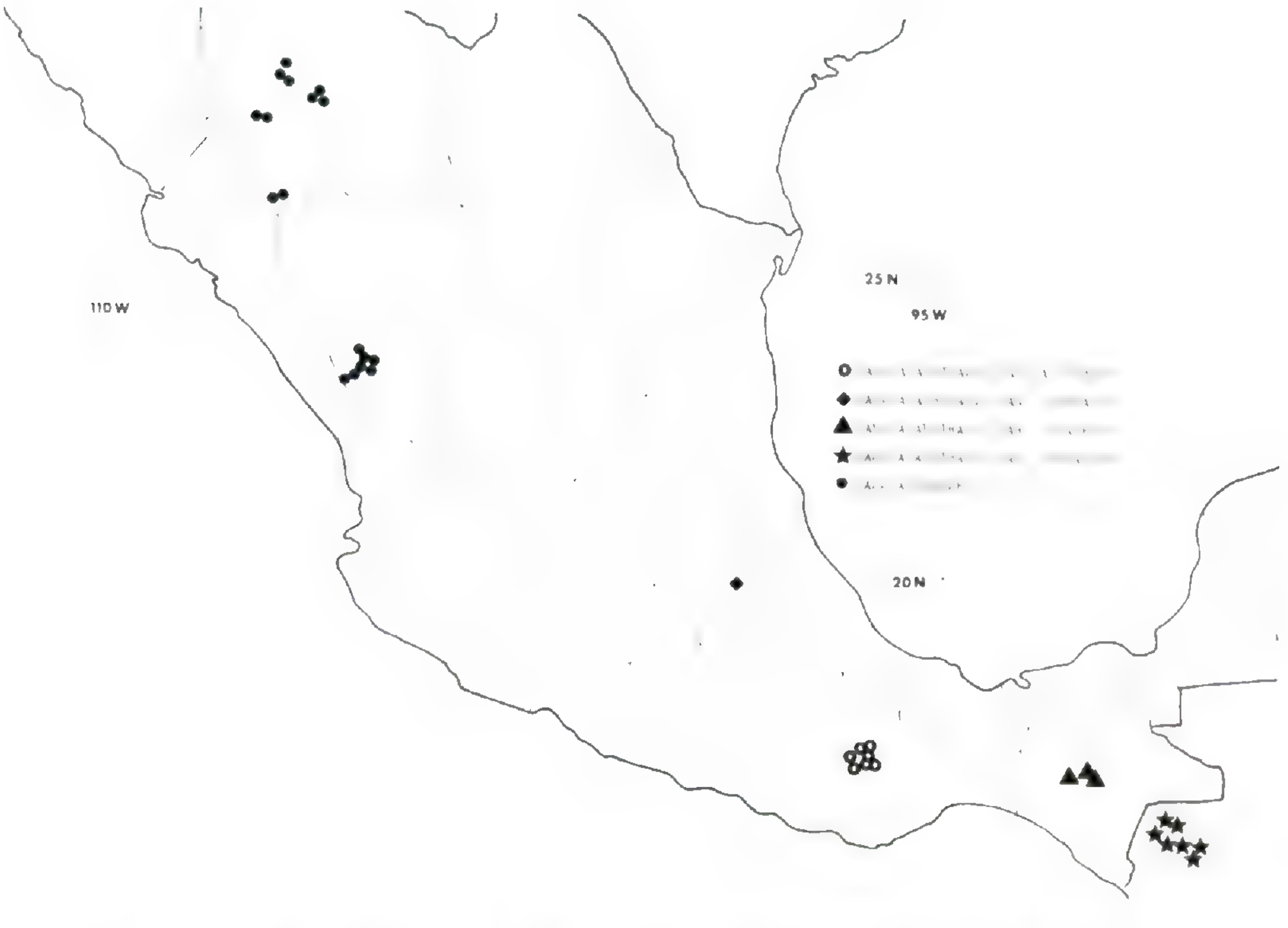
A. Petiole 0.9-1.3 cm. long; leaves 3-8 cm. long. ..... 22b. *D. australis* var. *liebmannii*.

A. Petiole (2-)3.8-10 cm. long; leaves 7.5-21 cm. long.
  B. Plants mostly of a compact growth habit with median internodes (1-)3-15 cm. long, stems with leaves often inferiorly clustered; outer involucral bracts 7-12 mm. long.
    C. Terminal leaflet often 3-lobed, sessile with strongly decurrent margins forming a pseudopetiolule; leaflets (of 1-pinnate leaves) oblong-ovate, markedly bicolored, the lower surface much lighter or silvery green. ..... 22a. *D. australis* var. *australis*.
    C. Terminal leaflet usually not lobed nor divided and without strongly decurrent margins forming a pseudopetiolule; leaflets (esp. the terminal one) often narrowly rhombic-ovate, not strongly bicolored, the lower surface rarely markedly lighter or silvery-green. ..... 22c. *D. australis* var. *chiapensis*.
  B. Plants mostly taller growing with longer internodes (7-)13-19 (-28.5) cm. long, stems leafy; outer involucral bracts (9-)12-15 mm. long. ..... 22d. *D. australis* var. *serratior*.

Dahlia australis is apparently quite closely related to *D. sherffii* of Durango and Chihuahua of northwestern México (see Map 6). Indeed, attempts to derive artificial hybrids between them have been highly successful. The hybrid plants are very robust, flower the first season of growth, possess no visible deleterious irregularities at ana-

phase and produce virtually 100% stainable pollen (using cotton-blue dissolved in lactophenol).

Although geographically isolated by about 900 miles, there is a considerable amount of morphological overlap between the taxa comprising the *Dahlia australis-sherffii* species complex. Fox example, a few individuals of *D. sherffii* display the markedly bicolored leaves which characterize *D. australis*. Similarly, the leaves on a few specimens of *D. australis* have upper leaf surfaces just as pubescent as those typically found in *D. sherffii*. Also, the dimensions and, to a limited extent, the segmentation of leaves and leaflets of both species overlap completely, and both produce leaflets rather attenuate-narrowed (not rounded) at the base.



Map 6. Distribution of the *Dahlia australis-sherffii* species complex: *Dahlia australis* var. *australis* (Sherff) Sorsensen, open circles; *Dahlia australis* var. *liebmannii* (Sherff) Sorensen, diamond; *Dahlia australis* var. *chiapensis* Sorensen, triangles; *Dahlia australis* var. *serratior* (Sherff) Sorensen, stars; *Dahlia sherffii* Sorensen, closed circles.

Dahlia australis is distinguished from *D. sherffii* (1) by its markedly bicolored leaves which are much lighter, almost silvery-green beneath, (2) by the mostly glabrous (not pubescent) and rugose (not smooth) upper surface of its leaves, and (3) by its sometimes slightly revolute (not flattened) leaflet margins.

22a. **Dahlia australis** (Sherff) Sorensen var. **australis,** TYPE: MEXICO: OAXACA: Cerro de San Felipe, 2500 m., 1 Sep. 1897, *Conzatti & Gonzalez* 543 (Holotype: GH!).

Dahlia scapigera var. *australis* et f. *australis* Sherff, Am. Jour. Bot. **34:** 143. 1947. Type: that of *Dahlia australis* var. *australis.*

Dahlia scapigera var. *australis* f. *purpurea* Sherff, *Ibid.* p. 145. Type: *Conzatti & Gonzalez 402,* Oaxaca, México (Holotype: GH!).

Herbaceous perennial 7-12 dm. tall. Stem 2-5 mm. diam., glabrous or pubescent; internodes 3.5-12 cm. long. Leaves usually once-pinnate but ranging from pinnatifid to bipinnate, 7.5-21 cm. long; basal pinnae 2-9.5 cm. long, sessile or rarely stalked, petiolule 10-13 mm. long, terminal leaflet often 3-lobed, sessile or pseudopetiolulate; surfaces conspicuously bicolored, green or dark green above, gray or silvery-green and salient veiny beneath, the upper rugose, glabrous or with a few scattered hairs near the margins and apex, the lower pubescent, esp. along the veins; margins irregularly serrate to crenate-dentate, 2-10 teeth per side, slightly revolute; petiole 2-8 (-10) cm. long. Heads with outer involucral bracts 7-12 mm. long, 1.5-3 mm. wide, narrowly oblanceolate; rays purple, 2.8-3.5 cm. long, about 1.5 cm. wide, ovate acute; disc florets 39-67, 6-9 mm. long, the limb from yellow throughout to purple throughout with many intermediates, corolla lobes often reflexed or revolute; achenes 8-9 mm. long, 2.8-3 mm. wide, linear-oblanceolate. Chromosome numbers, $n = 16$ & 32.

Known only from ledges and rocky slopes at altitudes of 7000 to 11,000 ft. in the vicinity of Cerro de San Felipe and Cerro Zempoalteptl, north-northeast and northeast of Oaxaca City, Oaxaca, México. Flowering June-Oct. Map 6, open circles.

MEXICO. OAXACA: summit and slopes of Cerro de San Felipe near Ciudad Oaxaca, *Conzatti* 55 (GH, US), 4078 (MEXU), 544 (GH, US), *Nelson* 1161 (US), *Pringle* 5620 (GH, MEXU), *C. L. Smith* 294 (IA); various localities from about 12 to 48 mi. N. of Ciudad Oaxaca along route 175 to Valle Nacional, *Cronquist* 9655 (MEXU, MICH, NY, TEX), *King* 2076 (MICH), *Krueger & Gillespie* 35 (CAS, GH, MO),

Melchert & Sorensen 6173 *A-C* (IA), 6174 *A-G* (IA), 6184 (IA), 6185 *A-D* (IA), 6192 *A-E* (IA), *Roe & Roe* 2004 (A, WIS); slopes of Cerro Zempoalteptl, *Hallberg* 896 (MICH), *Nelson* 640 (US).

Sherff (1947, 1955) established *Dahlia australis* var. *australis* as var. *australis* of *D. scapigera* sensu lato (see Table 2). Within his var. *australis* he described two subvarietal taxa, f. *australis* with yellow disc florets and f. *purpurea* with purple disc florets. In the present treatment Sherff's var. *australis* has been separated from *D. scapigera* sensu stricto (see Table 2) and elevated to the rank of species. Moreover, neither of the two color forms recognized by him are treated as separate taxonomic units inasmuch as the intensity and the amount of the disc corollas so colored varies from plant to plant within a single population.[7]

Dahlia australis var. *australis* is the only taxon within this species for which cytological information is available. In this regard, it is a rather interesting taxon because among the purple-rayed dahlias it is the only one represented by both diploid and tetraploid races. During August 1965, Dr. Thomas Melchert and I sampled 5 populations (representing 12 individual chromosome counts) along a 41-mile stretch of highway (route 175) leading northeast from Oaxaca City to Valle Nacional: at mile 12 we counted $n = 32$ (*6173*); at mile 15, $n = 32$ (*6174*); at mile 17, $n = 16$ (*6184*); at mile 21, $n = 32$ (*6185*); and near mile 41, $n = 16$ again (*6192*). To date I have been unable to detect morphologic markers which would distinguish the diploid and tetraploid populations or individuals.

Morphologically, the Oaxacan *Dahlia australis* var. *australis* is distinguished from its allied varieties by several characters of its leaves: (1) surfaces markedly bicolored, much lighter green, almost silvery-green beneath, the upper noticeably rugose, glabrous, or with a few scattered hairs near the margins and apex, the lower often strongly reticulate veiny, pubescent, esp. along the principal veins; (2)

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[7]Similar color variation is met with in several other *Dahlia spp.*, *D. merckii*, *D. sherffii*, *D. brevis*, *D. imperialis*, and *D. dissecta*.

the terminal leaflet often 3-lobed, sessile or pseudopetiolulate; (3) the basal leaflet of 1-pinnate leaves oblong-obvate; (4) margins crenate-dentate, the teeth often protruding slightly beyond the outline of the blade.

22b. **Dahlia australis** var. **liebmannii** (Sherff) Sorensen, comb. nov. TYPE: MEXICO: HIDALGO (?): between San Andres and San Miguel, Oct. 1842, *Liebmann* 688 (=9782) (Holotype: F!; Isotype; US!).

Dahlia scapigera var. *liebmannii* Sherff, Am. Jour. Bot. **143.** 1947. Type: that of *Dahlia australis* var. *liebmannii.*

Herb, at least 4.6 dm. tall. Stems 2-3.5 mm. diam., glabrous or sparsely pubescent with a few scattered soft hairs; internodes 14-24 cm. long. Leaves once-pinnate, 3-8 cm. long; the basal pinnae 1.5-4 cm. long, 0.5-1.3 cm. wide, ovate or ovate-lanceolate, sessile or short-stalked, the petiolule 1-3 mm. long; surfaces bicolored, conspicuously lighter green beneath, rugose above, the upper glabrous or puberulent, the lower pubescent, esp. along the veins; margins evenly serrate, 5-8 teeth per side, slightly revolute; petioles 9-13 mm. long. Heads with outer involucral bracts 7-11 mm. long, 1.5-2 mm. wide, linear-oblanceolate; rays light purple, 1.7-2 cm. long, 8-10 mm. wide; disc florets purple-tipped; achenes not seen.

Known only from the type locality. Map 6, diamond.

Very little can be said of this rather obscure taxon. A number of characters preserved in the type material (strongly bicolored leaves, slightly revolute margins, rugose texture of the upper surface of leaflets, slender stems) indicate that assigning it varietal rank under *Dahlia australis* is the most reasonable course to follow. This action is taken despite its apparent long geographic disjunction from the center of distribution of *D. australis* var. *australis.*

Collections of other Dahlias species by Frederick Liebmann have been definitely located in northeastern Puebla and adjacent Veracruz. This suggests that the type locality "between San Andres and San Miguel" could be a reference to two small mountain villages located east-northeast of Ixmiquilpan in central Hidalgo. Their location is not far distant from areas known to have been visited by this early collector.

Dahlia australis var. *liebmannii* may be distinguished from other *D. australis* vars. by its smaller leaves (3-8 cm. long) and its rather short petioles (0.5-1.3 cm. long).

22c. **Dahlia australis** var. **chiapensis** Sorensen, var. nov. TYPE: MEXICO: Chiapas: about 9 mi. SE. of San Cristóbal de las Casas along route 190, among boulders and on rocky ledges in zone of pine and oak, about 7500 ft., 23 Sep. 1966, *Melchert, Sorensen, & Crawford* 6458 (Holotype: IA!).

Herba perennis 4.5-7.5(-9.6) dm. alta, foliis aggregatis in caulibus base dense foliatis et internodiis 1-3 cm. longis, vel foliis plus distantibus in caulibus elongatis et internodis 5-15 cm. longis. Caules superne glabri, inferne praesertim ad nodis plus pubescentes. Folia pinnatifida ad pinnata, rarenter bipinnata, 9-18 cm. longa; foliolis 3-5, angusto-ovatis ad rhombico-ovatis, pinnis basilaribus 3-7 cm. longis, 0.8-3 cm. latis, saepe asymetricis cum lobo singulari sessili prope basin in margine proximali; paginis bicoloribus, dorsaliter pallido-viridibus vel cano-viridibus, praesertim ad nervos pubescentibus, ventraliter vere glabris; marginibus serratis ad dentato-crenatis dentibus in quoque latere 3-6; stipellis, ubi praesentia, ovatis ad rhombicis; petiolis 3.8-9.5 cm. longis. Capitula (1-)2-3 in quoque ramo, erecta ver subcernua; involucri squamis exterioribus effusis vel reflexis sub anthesi, 7-11 mm. longis, 1.8-3 mm. latis. Flores ligulati lilacini, ± 2.4 cm. longi, 1.5 cm. lati; flores tubulosi 44-52, luteis, interdum apicibus lilacini. Fig. 8.

Rocky slopes and ledges, 7000-8500 ft., in highlands of Central Chiapas. Flowering Aug.-Nov. Map 6, triangles.

MEXICO: CHIAPAS: from about 9 mi. SE. to about 6 mi. W. of San Cristóbal de las Casas along route 190, *Breedlove* 7095 (DS, F, MICH), 7307 (DS, F, MICH). 13762 (DS, MEXU), *Breedlove & Raven* 13412 (DS), *Ghiesbreght* 154 (GH, NY), 558 (GH, MO, NY), *MacDougall s.n.* (F), 365 (US).

The geogaphic range of *Dahlia australis* var. *chiapensis* is separated from that of var. *australis* in Oaxaca by roughly 250 miles. As with most taxa in the genus *Dahlia*, these varieties are found only at rather lofty elevations. It is important, therefore, to note that the elevations of the area between the distribution centers of vars. *australis* and *chiapensis* are much below those of their known localities. This is easily determined from topographic maps of the area. It is unlikely that this intervening area offers suitable

Plate 1422

Fig. 8. *Dahlia australis* var. *chiapensis* Sorensen. Photograph of type (IA), × 1/3.

habitats where other populations of *D. australis* would be found. For these reasons, it is believed that these varieties are effectively isolated from one another by the 250-mile disjunction between their distribution centers. *Dahlia australis* var. *serratior* of Guatemala, a close ally of var. *chiapensis*, is similarly isolated by about 130 miles and the absence of suitable habitats in the area between their distribution centers.

As mentioned in the discussion of *Dahlia australis* the features which mark the varieties of this species are mostly quantitative in nature. Thus, while closely resembling var. *australis* and var. *serratior*, var. *chiapensis* may be distinguished by the following characteristics: (1) mostly compact growth habit with leaves crowded near base; (2) undersurface of leaflets lighter green, rarely markedly lighter or silvery-green; (3) terminal leaflet usually unlobed or divided and without strongly decurrent margins forming a pseudopetiolule; (4) leaflets, esp. the terminal one, often narrowly rhombic-ovate; (5) basal pinnae often asymmetrical with a single sessile lobe near the base of the blade on the proximal edge. Without careful scrutiny these lobes tend to resemble stipels.

22d. **Dahlia australis** var. **serratior** (Sherff) Sorensen, comb. & stat. nov. TYPE: GUATEMALA: Dept. HUEHUETENANGO: rocky bushy bank, San Juan Atitán, 8200 ft., 9 Sep. 1934, *Skutch* 1180 (Holotype: GH!).

Dahlia scapigera var. *scapigera* f. *serratior* Sherff, Am. Jour. Bot. 34: 142. 1947. Type: that of *Dahlia australis* var. *serratior*.

Perennial herb, 6.4-12.3 dm. tall. Stems 5-6 mm. diam., glabrous or sparsely pubescent throughout, sometimes slightly scabrous on lower portions; internodes (7-)13-18.5(-28.5) cm. long. Leaves once-pinnate to pinnate-pinnatifid, 12-20 cm. long; leaflets oblong or broadly rhombic-ovate, the basal pinnae 4-8 cm. long 1.3-3.7 cm. wide, sessile or pseudopetiolulate, rarely stalked, the terminal leaflet somewhat larger than its companion leaflets; surfaces bicolored, lighter green beneath, the upper rugose, usually glabrous, sometimes slightly pubescent near margins and apices, the lower glabrous to distinctly pubescent, conspicuously veiny; margins regularly serrate to dentate-

crenate, 5-9 teeth per side; petiole (3-)6-10 cm. long. Heads with outer involucral bracts (9-)12-15 mm. long, 2-6 mm. wide, oblong spatulate or more often obovate, strongly tapered toward the base; rays light or rosaceous purple, ovate, 3.4-4 cm. long, 1.4-1.9 cm. wide, acute and denticulate; disc florets 50-53, corolla yellow, tube about 8 mm. long; achenes linear-oblanceolate, 10-11.2 mm. long, 2-2.2 mm. wide.

Rocky banks, ledges and cliffs, 8200-12,100 ft., highlands of southwestern Guatemala. Flowering Aug.-Oct. Map 6, stars.

GUATEMALA: HUEHUETENANGO: in the Sierra de los Cuchumatanes, esp. in the vicinity of San Juan Atitán, *J. R. Johnston* 1975 (F), *Skutch* 1244 (GH), *Steyermark* 50318 (F), 51974 (F). SOLOLA: Los Encuentros, *J. R. Johnston* 986 (F). TOTONICAPAN: woods between Totonicapán and crest of mountains on road to Los Encuentros, *Moore & Cetto* 8193 (BH).

From *Dahlia australis* vars. *australis* and *chiapensis*, var. *serratior* may be distinguished by several characters as follows: (1) plants producing leafy stems (not compact with leaves clustered near the base); (2) midrib of leaflets often tan-colored beneath; (3) terminal leaflets not 3-lobed nor divided, broadly rhombic-ovate; (4) basal pinnae mostly pseudopetiolulate, rarely stalked; (5) outer involucral bracts typically rather large, (9-)12-15 mm. long.

23. **Dahlia sherffii** Sorensen, sp. nov. TYPE: MEXICO: DURANGO: 24 mi. W. of Durango, 2 mi. S. of El Soldado along route 40, Durango-Mazatlán, among boulders on a steep slope above highway in a plateau region of pine and oak, about 7500 ft., 4 Sep. 1966, *Melchert, Sorensen & Crawford* 6288 (Holotype: IA!).

Herba perennis, 6-13 dm. alta. Caules plerumque glabri, interdum pilis fasciculibus in nodis. Folia pinnata ad bipinnata, 11-27 cm. longa; foliolis primariis 3-7; pinnis basilaribus 6-13 cm. longis, segmentis ultimis ovato-lanceolatis, acutis, basi attenuatis, interdum obliquis; paginis leviter bicoloribus, abaxialiter pallido-viridibus vel cano-viridibus ventraliter leviter pubescentibus, dorsaliter pubescentibus, praesertim in nervis; marginibus dentatis vel grosse serratis, dentibus 2-8 in quoque latere; stipellis plerumque in nodis basilaribus,

interdum in secundis etiam. Pedunculis 5-22 cm. longis; involucri squamis exterioribus effusis vel reflexis sub anthesi, 9-12 mm. longis, 3-4.2 mm. latis, ventraliter, glabris vel adpresso-pubescentibus dorsaliter 5-12-lineatis. Flores ligulati lilacini inferne saepe luteo-maculati, 2.8-4.2 cm. longi, 1.8-2.1 cm. lati; flores tubulosi 56-68, lobis corollae effusis nec reflexis nec revolutis; acheniis 7.1-11.5 mm. longis, 2.2-3 mm. latis. Chromosomatum numerus: $n = 32$. Nomen celebrare Earl Edward Sherff (1886-1966), hominem longe studiosum Coreopsidinae. Fig. 9.

Open or lightly-wooded rocky slopes, ledges, fields, and roadsides, 6000-8500 ft., Sierra Madre Occidentál of Chihuahua and Durango. Flowering Aug.-Sep. Map 6, closed circles.

MEXICO. CHIHUAHUA: vicinity of Pilares de Majalca about 40 mi. NW. of Chihuahua City, *Hawkes et al.* 1235 (F), *Le Seur* 24 (CAS, F, GH, MO, TEX, UC), White 2383 (GH); 10 to 16 road mi. S. of Madera on road to Temósachic, *Melchert et al.* 6274 *A-C* (IA), 6272 *pop* (IA), *Muller* 3466 (GH, UC); vicinity of Cerro Mohinora, *Gentry et al.* 17993 (US) *Straw & Forman* (MICH); vicinity of Majorachic (Maguarichic), *Knobloch* 1188 (MICH, MO), 5292 (F, MSC). DURANGO: from 34 to 63 road mi. N. of Coyotes RR., *Maysilles* 7512 (F, MEXU, MICH, NY), 7928 (MICH), 8374 (MICH), 8401-A (MICH); 20 km. S. of El Salto at Arroyo del Infierno, *Gordon* 74 (MICH); 24 mi. SW. of Durango along route 40, *King* 3743 (TEX); 36 mi. W. of Durango along route 40, *Melchert & Sorensen* 6031 (IA), 6032 (IA); 10 mi. E. of La Ciudad along route 40, *Melchert et al.* 6304 (IA); 21.7 mi. NE. of El Paraiso along road to El Salto, *Ownbey & Ownbey* 1981 (F, UC, US).

Dahlia sherffii is a new species which was discovered among those taxa formerly treated by Sherff (1955) as part of *D. scapigera* sensu lato (see Table 2). Although geographically separated by about 900 miles, *D. sherffii* seems quite closely related to *D. australis* and its varieties of Oaxaca, Chiapas, and Guatemala as discussed above.

From the pattern of distribution of this species (Map 6, closed circles) one is given the impression that *D. sherffii* is distributed only in two geographic areas isolated from each other by about 250 miles. It is believed this distribution pattern reflects more the distribution of places where collections have been made than the real distribution of the species. This belief is based on first-hand knowledge of the type of habitat of the species and on a survey of

Plate 1423

Fig. 9. *Dahlia sherffii* Sorensen. Photograph of type (IA), × 1/3.

topographical maps of the area. It is seen from these maps that the region between the distribution centers of this species is continuously mountainous and would be expected to provide suitable habitats the entire distance. Moreover, this range of mountains continues for a considerable distance south and north of these distribution centers. It is reasonable, therefore, to expect the present range extremities of *D. sherffii* to be altered as the area becomes more thoroughly investigated.

A certain amount of morphological diversity is displayed in the collections of *D. sherffii* available to me. This variation prmarily involves the amount of segmentation of the leaves (from 1-pinnate to bipinnate-pinnatifid), and it correlates partly with the north-south distribution of the species. For example, the leaves on several specimens collected in Chihuahua display a greater amount of segmentation than those collected in Durango. In some cases, however, almost an equivalent amount may be observed between populations within the respective geographic areas. Despite such variation the species is held together by a number of technical characters of its leaves. These are listed below along with the contrasting characteristics which distinguish the closely related *D. australis*, mentioned above, from *D. sherffii:* (1) the upper surface of leaves pubescent (not glabrous), the hairs broadly but evenly spaced between the main veins throughout; (2) the lower surface slightly lighter green (not markedly lighter or silvery green); (3) the texture of leaflets smooth (not rugose); and (4) margins of leaflets flat (not revolute).

24. **Dahlia scapigera** (A. Dietr.) Knowles & Westc. Fl. Cab. 3: 113, *pl. 118*. 1839. TYPE. MEXICO: MÉXICO or MICHOACAN: between San Joaquin and Angangueo (presumed to be the Angangueo, Michoacán just W. of the México state boundary), Sep. 1830, *Schiede s.n.* (Holotype: B[?]; Isotype: US!).

Georgina scapigera A. Dietr., in Otto & Dietr. Allg.

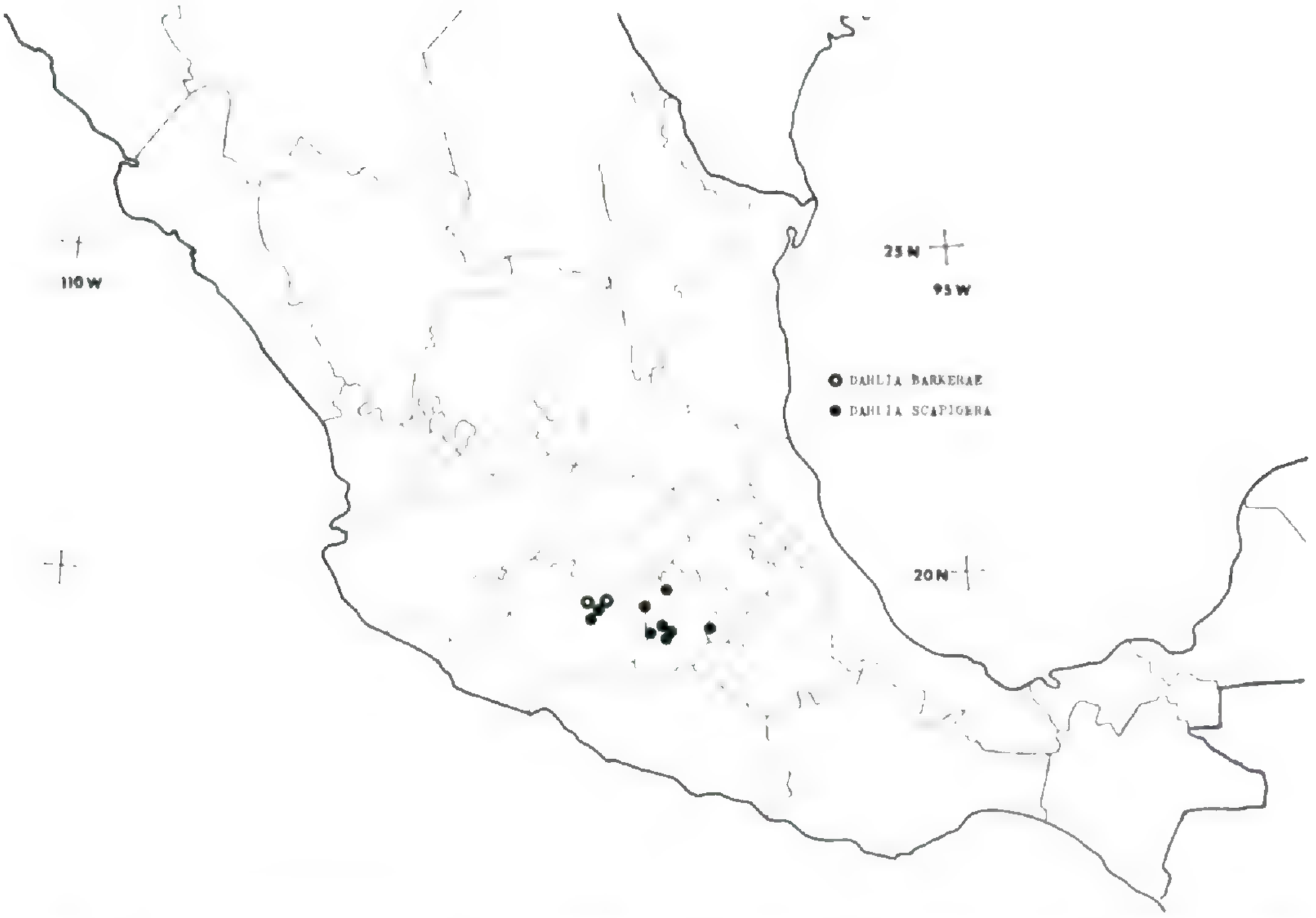
Garten. **1:** 197. 1833. Type: that of *Dahlia scapigera.*

Dahlia scapigera var. *typica* f. *typica* Sherff, Am. Jour. Bot. **34:** 139. 1947. Type: that of *Dahlia scapigera.*

Herb, 2.8-4.5(-6) dm. tall, the principal leaves crowded, rosette-like, near the base of the stem. Stem 2-3 mm. diam., glabrous, sometimes with a few hairs at the nodes; internodes 0-4 mm. (in shade forms the internodes may elongate to 2 cm.). Leaves pinnate to pinnate-pinnatifid, rarely almost bipinnate, 6-20 cm. long; leaflets 3-5(-7), sessile, rarely very short stalked, broadly ovate or ovate-lanceolate, 13-35 mm. long, 4-19 mm. wide; surfaces bicolored, lighter green beneath, the upper rugose, glabrous, the lower salient veiny, glabrous or sometimes a few scattered hairs along the principal veins; margins irregularly ciliolate, the cilia short and stiff, serrate with (1-)3-4(-5) teeth per side; stipels often present and then at the second node from the base; rachis glabrous except for a few soft hairs at the junction with the leaflets. Heads few, seldom more than one per plant, campanulate, subcernuous; outer involucral bracts erect or ascending (not strongly reflexed) at anthesis, 7-11 mm. long, 1.8-3 mm. wide, linear-oblanceolate or spatulate, glabrous, dorsally 3-5-lined, inner bracts 12-15 mm. long, 4-6 mm. wide; chaff yellowish, drying to tan; rays whitish-lavender to light-purple, sometimes with a yellow spot at the base, 1.8-3.5 cm. long, 0.8-1.5 cm. wide, ovate, acute or denticulate; disc florets 48-62, yellow, often tinged with purple at tips, 7-8 mm. long, corolla lobes spreading at anthesis, style branches 3-4.2 mm. long, about 0.8 mm. wide, linear lanceolate-attenuate; achenes (from greenhouse plants) 5-7 mm. long, 1.2-2 mm. wide, spatulate or at least linear-oblanceolate, blackish, minutely pubescent, many-sulcate pappus obsolete or consisting of 2 minute rudiments. Chromosome number, $n = 16$.

Cool, open or lightly-wooded, rocky volcanic slopes, in deep loamy soil, 8600-12,600 ft., from Distrito Federal, just southwest of México City, west to Pico de Tancítaro, Michoacán, and on several high volcanic peaks in between. Flowering July-Sep. Map 7, closed circles.

MEXICO. MEXICO: slopes of Volcán de Toluca, *Balls* 5047 (UC, US), *Barkley et al.* 79 (F, TEX, US), *Melchert & Sorensen* 6119 *A-T* (IA), 6217 *A-B* (IA), *Roe et al.* 303 (A, WIS), *Ugent et al.* 1211 (WIS); Distr. of Temascaltepec, Las Cruces, *Hinton* 1039 (GH, MO, US); 9 mi. NE. of San Francisco Cheje along route 130, *King* 3570 (DS, MICH, NY, RSA, TEX, UC, US); woods near Aculco, *Matuda* 28883 (MEXU, NY); Cerro de Jilotepec, *Matuda* 29117 (NY). DISTRITO



Map 7. Distribution of *Dahlia barkerae* Knowles & Westc., open circles; and *Dahlia scapigera* (A. Dietr.) Knowles & Westc., closed circles.

FEDERAL: Peña de las Charras, *Russell & Souviron* 142 (CAS, US). MICHOACAN: summit and slopes of Cerro Tancítaro, *Leavenworth* 273 (F), 688 (F), 1103 (F, GH, MO); Cerro Pelón near Zitácuaro, *Hinton* 13239 (GH, MICH, NY, UC, US); mountains near Pátzcuaro, *Pringle* 4162 (F, GH, ISC, MEXU, MICH, MO, NY, UC, US); Cerro de San Miguel (state not given), *Reiche s.n.* (MEXU).

In a series of articles Sherff (1946, 1947, 1955) gradually enlarged his concept of *Dahlia scapigera* (see Table 2) to include a wide assortment of taxa. To accommodate these he established a number of taxonomic varieties and forms which were brought together in their final version in his revision of *Dahlia* (1955).

I have had the opportunity to observe all but two of Sherff's intraspecific taxa of *D. scapigera* in the field. From these observations and after examining numerous herbarium specimens matched with Sherff's published exsiccatae it was apparent that five rather distinct, and in some cases, unrelated species were included within *D. scapigera*. Briefly, these five species are characterized as

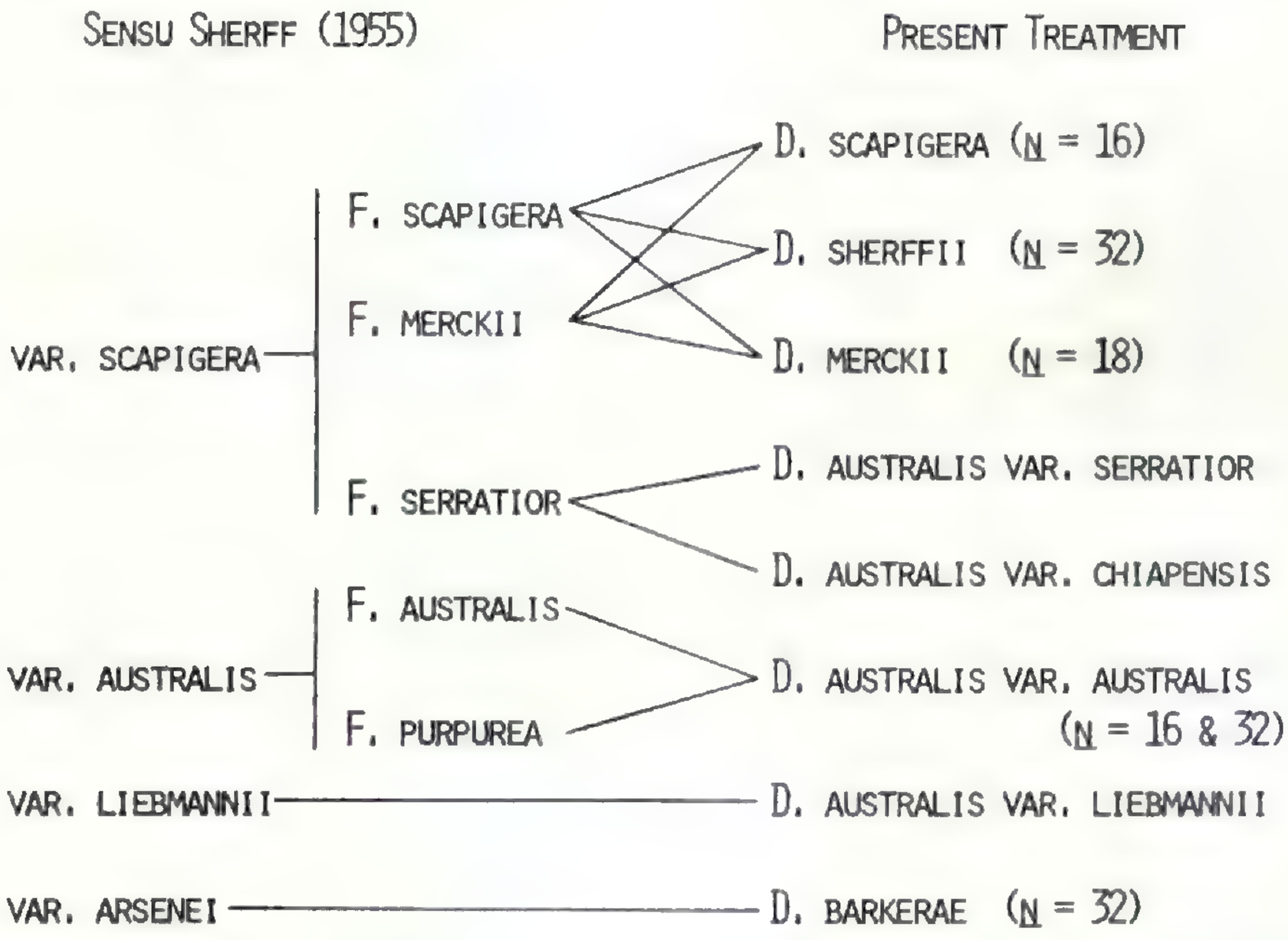


Table 2. Disposition of *Dahlia scapigera* sensu Sherff (1955)

follows: (1) *D. scapigera* sensu stricto, plants of compact growth habit found only at very high elevations on volcanic peaks in south-central México and hardly over 4 dm. tall with mostly 1-pinnate, glabrous leaves (chromosome number, $n = 16$); (2) *D. barkerae*, plants of compact growth habit, resembling *D. scapigera* but with larger and very hairy leaves and leaflets, stems remarkably hairy, ridges and cliffs, vicinity of Morelia, Michoacán (chromosome number, $n = 32$); (3) *D. sherffii* sp. nov., plants 6-13 dm. tall, leafy stems, 1-3-pinnate, pubescent leaves, on rocky ledges and along roadsides in northwestern México (chromosome number, $n = 32$); (4) *D. merckii*, plants 4.5-18.5 dm. tall, leafy portion 1/3 to 1/2 the height, leaves glabrous, mostly bipinnate with pinnules alternate on the rachilla, petioles hollow and fleshy, ledges and open lava fields in south-central México (chromosome number, $n = 18$); and (5) *D. australis* incl. 3 vars., leaves strongly bicolored, the lower surface much lighter or silvery green, pubescent, upper surface rugose, glabrous, central Oaxaca eastward into western Guatemala (chromosome number, $n = 16$ & 32). These segregates are discussed in turn fol-

lowing their individual taxonomic treatment. Table 2 contrasts and summarizes the present treatment and that of Sherff (1955).

Dahlia scapigera sensu stricto (chromosome number, $n = 16$) is a rather specialized species characterized by its extremely dwarfed, almost rosette-like, growth habit and by its relatively few campanulate flowering heads (usually only 1 or 2 per plant). It seems most closely related to, and possibly was involved in the derivation of, *D. barkerae* (chromosome number, $n = 32$). The ranges of these two species are almost sympatric and morphologically the species have in common a rugose leaf texture, mostly once-pinnate leaves with 3-5 sessile leaflets, a compact growth habit and erect or ascending outer involucral bracts. In addition to its chromosome number, *D. scapigera* is easily distinguished from *D. barkerae* by its fewer heads and by its more nearly glabrous (not conspicuously pubescent) herbage. When seen in the fresh condition, the leaves of *D. barkerae* are a much darker glossy green above.

25. **Dahlia barkerae** Knowles & Westc. Fl. Cab. **2:** 28. 1838; & Fl. Cab. **3:** 147, *pl. 127*. 1839. Type: Cultivated in Springfield, near Birmingham, England, 1837, from material collected in the vicinity of Valladolid (now called Morelia), Michoacán, México, 1836-1837, *Barker s.n.* (Holotype: BM [?]).

Dahlia scapigera var. *arsenei* Sherff, Am. Jour. Bot. **33:** 508. 1946. Type: *Arsène* 5520 Cerro Azul, vicinity of Morelia, June 1910 (Holotype: GH!; Isotypes: F!, MO!, NY!, US!).

Herb, leaves crowded near base, 3-4.5 dm. tall, or with elongate internodes, then 6-7 dm. tall. Stem 3-4 mm. diam., densely pubescent, the hairs 2-4 mm. long, conspicuously multicellular, glistening white or silvery, flexuous; internodes of compact plants 0.0-1(-6.5) cm., of elongate plants 6-14 cm. (the latter growing in shaded habitats, the former in more open situations). Leaves once-pinnate, 16-29 cm. long; leafllets (3-)5-7, 1-3.5 cm. long, 0.7-2.8 cm. wide, the terminal leaflet much larger than its companion leaflets, broadly ovate to suborbicular, apex acute or subacute, rounded, truncate or even cor-

date at base, sessile or stalked, the petiolules less than 5 mm. long; surfaces bi-colored, the upper dark, shiny green, noticeably rugose (esp. when fresh), glabrous or minutely pubescent along the deeply impressed veins, the lower lighter green or gray-green, densely pubescent esp. along the conspicuous veins; margins ciliolate and coarsely serrate to dentate with 1-5 teeth per side; stipels sometimes present, attached at either the first or second rachis nodes; petiole 2.5-6 cm. long, slightly winged esp. in proximal portion, pubescent; rachis pubescent, the hairs becoming floculent at the junctions with the leaflets. Heads several on a plant, in 2's and 3's, obliquely erect or slightly nodding, on peduncles 5.5-13 cm. long; outer involucral bracts erect at anthesis, dorsally glabrous, 3-5-lined, 6-6.5 mm. long, 2.5-3 mm. wide, elliptical or obovate, apex subacute or obtuse; inner bracts about 14 mm. long, 4.5-7 mm. wide, purple-lined; rays light purple, 26-32 mm. long, 14-17 mm. wide, ovate, acute or denticulate; chaff membranous, resembling the inner bracts; disc florets 48-60, yellow, the corolla about 8 mm. long, (excluding ovary), its lobes spreading or reflexed at anthesis; style branches 2.7-3 mm. long; achenes not seen. Chromosome number, $n = 32$.

Rocky slopes and ledges, about 7000 ft., within a 20 mile radius of Morelia, Michoacán. Flowering June-Sept. Map 7, open circles.

MEXICO. MICHOACAN: Cerro Azul, vicinity of Morelia, *Arsène* 18 (F), 5520 (GH); Campanario, *Arsène* 6787 (F [photo]); 17 mi. E. of Morelia along route 15, cañon of the Río del Salto, about 8500 ft., *Melchert et al.* 6414 *A-C* (IA).

Dahlia barkerae was described in 1838 from material cultivated in England following its introduction from "the forests of Valladolid" (the Valladolid now called Morelia in Michoacán) in México. In 1946, Sherff applied the name *D. barkerae* to a group of specimens (*Pringle 3164*) which had been named *D. pubescens* by S. Watson (1891), but now called *D. brevis*. In the same paper (1946) Sherff described the new variety *D. scapigera* var. *arsenei*. The description was drawn from plants collected on Cerro Azul near Morelia. In September 1966 the type locality of *D. scapigera* var. *arsenei* was revisited and plants were found (*Melchert et al. 6414 A*-C) which seemed to be Sherff's variety. Subsequently, however, the original description and accompanying plate of *D. barkerae* were seen and from these it became apparent that Sherff had misapplied the name *D. barkerae* to the species which had

been described as *D. pubescens* by Watson (here referred to as *D. brevis*).

Dahlia barkerae seems closely related to the more widely distributed *D. scapigera*. With the latter it shares a compact habit, mostly once-pinnate leaves with leaflets that have a rugose texture on the upper surface, erect (not greatly spreading or reflexed) outer involucral bracts and slightly pendulous heads. *D. barkerae* may be distinguished from *D. scapigera* by its more branched habit with heads developing mostly in 2's and 3's, by its generally larger leaflets which are dark shiny green above and light green beneath, by its densely pubescent stem and lower leaf surfaces, and by its chromosome number of $n = 32$.

26. **Dahlia tenuis** Robins. & Greenm. Proc. Am. Acad. 32: 48. 1896. TYPE: MEXICO: OAXACA: 18 mi. SW. of Oaxaca, 7500-9500 ft., 10 Sep. 1894, *Nelson* 1364 (Holotype: US!; Isotypes: F!, GH!).

Herb 2.5-6 dm. tall. Stem slender, 1.5-4 mm. diam., obscurely many-striate, conspicuously pubescent, the hairs mostly retrorsely curved, more dense at the nodes; internodes 2.5-9.5 cm. long. Leaves pinnate-pinnatifid or pinnate-pinnatisect, 6-11 cm. long; leaflets or primary divisions 5-7, 2-3.5 cm. long, lanceolate, irregularly lobed, pinnatisect or merely toothed with 1-3 teeth per side; surfaces bicolored, dorsally lighter green and conspicuously veiny, the upper surface pubescent along the main veins, the lower pubescent, esp. along the principal veins; margins obscurely ciliolate, the cilia blunt, irregularly spaced; stipels sometimes present at the basal rachis node; petiole 0.8-4.5 cm. long, longitudinally grooved above, rounded beneath, pubescent, sometimes narrowly winged with the decurrent bases of the leaflets; rachis pubescent, densely so at the junctions with the pinnae, narrowly winged. Heads 1-4 per plant or on each main branch, erect or obliquely erect, slightly campanulate at anthesis; outer involucral bracts reflexed at anthesis, 5-8 mm. long, usually less than 1.0 mm. wide, oblanceolate or spatulate, acute or sometimes obtuse, glabrous, dorsally purple striate with 4-7 parallel lines; inner bracts 12-14 mm. long, 3-8 mm. wide; chaff (in fruit) 11-13 mm. long, 4.5 mm. wide; rays yellow, 1-2.5 cm. long, 6-9 mm. wide, ovate, acute or denticulate; disc florets 17-35, yellow, 3.5-4.5 mm. long, corolla lobes reflexed or revolute; achenes 6-9 mm. long, 1.5-1.8 mm. wide, linear-spatulate, dark gray or almost black, obscurely sulcate, pappus absent or consisting of 2 minute aristae less than 1 mm. long. Chromosome number $n = 16$.

Steep rocky wooded slopes in zone of pine, 5000-8500 ft., from about 40 miles northwest of, to 18 miles southwest of Oaxaca, Oaxaca. Flowering Aug.-Sep.

MEXICO. OAXACA: from about 30 to 39 mi. N. of Oaxaca along route 190, *Iltis et al.* 1290 (MICH, TEX, WIS), *Jackson* 7192 (IA), *Melchert & Sorensen* 6167 *A-O* (IA), 6179 *A-M* (IA), 6181 (IA); Clavallinas Mts., *Pringle* 5807 (GH, MEXU, UC); mts. near Telixtlahuaca, *L. C. Smith* 481 (GH).

The relationship of *Dahlia tenuis* to any other known *Dahlia* species is, at present, obscure. Its yellow rays suggest an affinity with *D. coccinea,* but its dwarfed habit, small heads and low number of disc florets are quite different from those of any other species.

27. **Dahlia coccinea** Cav. Icones et Descr. Pl. 3: 33, *t. 266.* 1796. TYPE: exact place and date of collection not known; originally described by Cavanilles from plants cultivated at the Royal Botanic Gardens, Madrid, which had been grown from seed collected in México and sent to Spain by Vicente Cervantes, Director of the Mexican Botanic Garden, ca. 1789. (Holotype: MA, photo. F!).

Georgina coccinea (Cav.) Willd. Linn. Sp. Pl. ed. 4. 3: 2124-2125. 1803. Type: based on *Dahlia coccinea* Cav.

Dahlia crocata Sessé, Elenchus Hort. Reg. Matriti an. 1805, *nom. nud.,* cf. *Dahlia crocata* Sessé ex Lagasca below.

Dahlia bidentifolia Salisb. in Wm. Hooker, Parad. Lond. *t. 19.* 1805. Type: based on *Dahlia coccinea* Cav.

Georgina coccinea α coccinea (Cav.) Willd. Hort. Berol. 2: *pl. 96.* 1809. Lectotype: *pl. 96,* Willd. *loc. cit.* 1809.

Georgina coccinea β crocea Willd. Ibid. Lectotype: *pl. 96.* Willd. *loc. cit.* 1809.

Georgina coccinea γ flava Willd. Ibid. Lectotype: *pl. 96.* Willd. *loc. cit.* 1809.

Georgina frustranea α coccinea (Willd.) DC. Ann. Mus. Hist. Nat. Paris. Type: based on *Georgina coccinea α coccinea* (Cav.) Willd. (G-DC, microfiche libraries A-GH).

Georgina frustranea β crocea (Willd.) DC. *Ibid.* Type: based on *Georgina coccinea β crocea* Willd. (G-DC, microfiche libraries A-GH).

Georgina frustranea γ flava (Willd.) DC. *Ibid.* Type: based on *Georgina frustranea γ flava* Willd. (G-DC, microfiche libraries A-GH).

Dahlia crocea (Willd.) Poir. Lam. Encycl. Suppl. **2**: 445. 1812. Type: based on *Georgina coccinea β crocea* Willd.

Dahlia frustranea (DC.) Ait. f. Hort. Kew. ed. 2. **5**: 88. 1813. Type: based on *Georgina frustranea* [vars.] DC.

Dahlia crocata Sessé ex Lagasca, Elenchus Pl. Hort. Reg. Matriti an. 1815 et Gen. Sp. Pl. Nov. aut Minus Cognitarum, 30. 1816. Lectotype: description p. 30, Lagasca *loc. cit.* 1816.

Coreopsis georgina [var.] *pruinosa* Cass. Dict. Sci. Nat. **18**: 443. 1820. Type: based on *Georgina coccinea* [vars.] Willd. and *Georgina frustranea* [vars.] DC.

Georgina crocata (Sessé ex Lagasca) Sweet, Brit. Fl. Gard. **3**: *t. 282.* 1829. Type: based on *Dahlia crocata* Sessé ex Lagasca.

Georgina cervantesii Lagasca ex Sweet, *op. cit.* II. 1: *t. 22.* 1829. Lectotype: *t. 22*, Sweet *loc. cit.*

Dahlia cervantesii (Lagasca ex Sweet) DC. Prodr. **5**: 494. 1836. Type: based on *Georgina cervantesii* Lagasca ex Sweet (G-DC, microfiche libraries A-GH).

Coreopsis coronata Sessé & Moçiño, Pl. Nov. Hisp. 147. 1890, *non Coreopsis coronata* L. (1793). Lectotype: description p. 147, Sessé & Moçiño *loc. cit.* 1890.

Dahlia pinnata var. *cervantesii* (Lagasca ex Sweet) Voss in Vilmorin's Blumengart. 1: 489. 1894. Type: based on *Georgina cervantesii* Lagasca ex Sweet.

Dahlia pinnata var. *coccinea* (Cav.) Voss *Ibid.* Type: based on *Dahlia coccinea* Cav.

Dahlia pinnata var. *gracilis* (Ortgies) Voss *Ibid.* Type: based on *Dahlia gracilis* Ortgies.

Coreopsis crassifolia Sessé & Moçiño, Fl. Mex. ed. **2**: 194. 1894. Type: *Sessé, Moçiño, Castillo & Maldonado 2926* (Holotype: MA; Isotype: F!).

Dahlia chisholmii Rose, Proc. U.S. Nat. Mus. **29**: 439. 1905. Type: *Chisholm s.n.* near Arcelia, Guerrero, México (Holotype: US!; Isotypes: US!).

Dahlia popenovii Safford, Jour. Washington Acad. **9**: 369, fig. 3. 1919. Type: *Popenoe 682*, Dept. Zacatepequez, Guatemala (Holotype: US!).

Dahlia coronata Hort. ex Sprague, Bull. Misc. Info. Kew (Kew Bull.) 1929: 53. 1929. Type: Sprague cited no specimens in his treatment of this species, however, Sherff (1947) states there are at K four sheets of the Sprague study material, from plants cultivated at the John Innes Institution, Merton, England (Lectotype: K).

Dahlia gentryi Sherff, Am. Jour. Bot. **29**: 332. 1942. Type: *Gentry 6275*, Sinaloa, México (Holotype: F!; Isotypes: DS!, GH!, MICH!, MO!, NY!).

Dahlia coccinea var. *steyermarkii* Sherff, *Ibid.* **31:** 280. 1944; op. cit. **33:** 508. 1946. Type: *Steyermark 50341,* Dept. Huehuetenango, Guatemala (Holotype: F!).

Dahlia coccinea var. *palmeri* Sherff, *Ibid.* **33:** 508. 1946. Type: *Edw. Palmer 494,* vicinity of Durango, Durango, México (Holotype: US [2 sheets]!; Isotypes: F!, GH!, MO!, NY!).

Dahlia coccinea var. *coccinea* (Willd.) Sherff, *Ibid.* **34:** 149. 1947. Type: based on *Dahlia coccinea* Cav. and *Georgina coccinea* [vars.] Willd.

Dahlia coccinea var. *gentryi* Sherff, *Ibid.* **34:** 152. 1947. Type: based on *Dahlia gentryi* Sherff.

Herb 4.5-30 dm. tall. Stems usually unbranched in the flowering portion, 2-25 mm. diam., glabrous to densely pubescent esp. at the nodes, sometimes conspicuously glaucous, variously colored green to purple when fresh; nodes usually septate or incompletely so; internodes hollow, rarely solid, 2.5-30 cm. long. Leaves opposite or if whorled then with 3 per node, extremely variable from simple and unlobed to tripinnate, 12-35 cm. long including petiole; primary leaflets 3-11, sessile or petiolulate; basal pinnae 4.5-16 cm. long, its basal pinnule (of 2- or 3-pinnate leaves) 1.8-7 cm. long, terminal segment of leaves, pinnae and pinnule commonly slightly larger than its companion leaflets; ultimate segments broadly ovate to ovate-elliptical or narrowly ovate-lanceolate, rarely slightly obovate, apices usually acute or slightly acuminate bases usually tapered, sometimes rounded, truncate, and even slightly cordate; surfaces usually bicolored, lighter green or gay-green beneath, the upper glabrous or pubescent, sometimes coarsely scabrous, the lower rarely almost glabrous, usually conspicuously hairy along the veins; margins ciliolate, the cilia usually short and very stiff, infrequently longer and flexuous, variously crenate-dentate to coarsely or finely serrate with (1-)2-14 teeth per side; petiole grooved above, crescent-shaped in cross-section, sometimes very narrowly winged, glabrous or pubescent, 1-11 cm. long; primary rachis glabrous or pubescent, mostly with a conspicuous cluster of hairs at the junctions with the primary pinnae, often grooved above, sometimes winged, especially in the distal portions; stipels occurring irregularly, when present then usually at the second rachis node, simple to compound, sessile or stalked. Heads usually in 2's and 3's, erect or obliquely erect, on peduncles 2-30 cm. long; outer involucral bracts spreading or reflexed at anthesis, variously ovate to obovate or spatulate, usually obtuse but sometimes long acuminate-attenuate, 6-15 mm. long, 3-7 mm. wide, dorsally several to many-lined, occasionally reticulate veiny, glabrous, ventrally glabrous or puberulent, often cross-wrinkled; inner bracts brownish or scarlet throughout or just the tips scarlet, 11-17 mm. long, 3-8 mm. wide; rays 1.6-4 cm. long, 10-18 mm. wide, ovate-elliptical or merely

ovate, acute or denticulate, rarely lacerate at apex, lemon yellow to orange, orange scarlet, or deep blackish scarlet, sometimes variegated yellow and orange in a variety of combinations, dorsally puberulent along the veins, the hairs often gland-tipped, esp. those on the tube of the ligulate florets; chaff at anthesis 10-14 mm. long, 2-7 mm. wide, obtuse, pale greenish-yellow, scarlet or scarlet merely at the tips, disc florets 71-157, yellow or sometimes scarlet tipped, 8-10 mm. long, corolla lobes spreading or erect; style branches linear-lanceolate, flexuous, 4-4.5 mm. long, less than 0.8 mm. wide, achenes linear-oblanceolate to obovate or spatulate, 8-13 mm. long, 1.8-5.5 mm. wide, gray to black, sometimes black-speckled, usually minutely tuberculate, sometimes obscurely many-striate, of varied dimensions and texture sometimes within the same head; pappus obsolete or consisting of 2 minute rudiments, rarely greatly elongated into fine filiform threads, these very delicate and flexuous, usually deciduous. Chromosome number, $n = 16$ & 32.

Cliffs, ledges, steep rocky slopes, fields and roadsides, from about 1500 to 11,000 ft. Sinaloa, Chihuahua, Coahuila, Nuevo Leoń, and Tamaulipas in Northern México, south in moutains and plateau regions to southern and southeastern México and Guatemala; reported (H. H. Iltis, personal communication) naturalized in mountainous regions of Peru, should be sought also in other Andean countries of South America. Flowering June-Nov. Map 8.

MEXICO. TAMAULIPAS: E. side of Cerro Linadero, *Meyer & Rogers* 2747 (F, GH, MICH, MO, US), 2900 (BH, F, MO, US); between Marcella and Hermosa, *Stanford et al.* 2624 (NY, TEX, UC, US). NUEVO LEON: mts. in the vicinity of Monterrey and Cerro de la Cebolla, *Muller* 2877 (GH, UC), *Muller & Muller* 238 (F, GH, MEXU, TEX), *R. F. Smith* M612 (TEX). COAHUILA: Buenos Aires, *Kenoyer & Crum* 2833 (GH, MICH); La Casita, *Kenoyer & Crum* 4130 (GH); ledges and banks, Carneros Pass, *Pringle* 3166 (CAS, F, GH, MEXU, MO, MSC, NY, RSA, UC, US). CHIHUAHUA: Sierra Canelo, Río Mayo, *Gentry* 2493 (DS, F, GH, MEXU, MO, UC, US); Cascada de Basascachic, *Hewitt* 149 (GH); Maguarichic (Mojarachic) SW. of San Juanito, *Knobloch* 1270 (MICH, MSC), 5994 (MSC, US). SAN LUIS POTOSI: 6 mi. W. of Ahuacatlán, *Graber* 177 (US), 198 (US); Charcas, *Lundell* 5525 (MICH, US); 25 to 30 mi. E. of San Luis Postosí along route 86, *McGregor et al.* 574 (MSC), 646 (MSC), *Powell* 1144 (TEX). ZACATECAS: Along road to Huejuquilla el Alto, Jalisco, *McVaugh* 17687 (MICH); 13 mi. W. of Sombrerete, *Soderstrom* 747 (MICH, US); 18 km. W. of Concepción del Oro, *Stanford et al.* 601 (DS, GH, MO, NY, UC). DURANGO: 5 to 20 mi. W. of Durango City along route 40, *Melchert et al.* 6280 *A-B* & *pop* (IA), 6282 (IA), *Waterfall* 12551 (GH, MICH, US); 7-8 m. E. of

Map 8. Distribution of *Dahlia coccinea* Cav.

El Palmito along route 40, *Melchert et al.* 6316 (IA), 6318 *A-B* (IA); Cañon of the Río Jaral about 15 mi. NW. of Coyotes Station, *Cronquist* 9576 (MEXU, MICH, NY, US, TEX); fields along route 40, 29 mi. NE. of Durango City, *King* 3760 (MICH, NY, TEX, UC, US); at Coyotes Hacienda, 63 road miles WSW. of Durango City, *Maysilles* 7634 (F, MEXU, MICH, US); Ramos to Indé, *Nelson* 4714 (US); 16 mi. W. of El Ciudad along route 40, *Melchert et al.* 6313 (IA); Durango City and vicinity, *Palmer* 494 (F, GH, MO, NY, UC, US); mts. S. of La Purisma, *Shreve* 9182 (GH). SINALOA: Ocurahui, Sierra Suratato, *Gentry* 6302 (DS, GH, MICH, NY, US); 1-2 m. SW. of Sinaloa-Durango border along route 40, *King* 3722 (DS, MEXU, MICH, NY, TEX, UC, US); Yxtagua, *Ortega* 124 (MEXU); near Colomos, *Rose* 1779 (US); Cerro del Perico, San Ignacio, *Salazar* 534 (US). HIDALGO: 15-20 mi. N. of Zimapán in the Barranca de San Vicente, along route 85, *Fearing & Thompson* 62 (TEX), *Melchert & Sorensen* 6206 (IA), *Moore* 3376 (BH, GH), *Straw & Gregory* 1145 (GH, MEXU, MICH, RSA); 4-5 mi. N. of Jacala along route 85, *Moore* 1790 (BH), *Weber & Charette* 11911 (US); 12 mi. W. of Pachuca along route 85, *Melchert & Sorensen* 6203 *A-F* (IA); 7 mi. S. of Jacala, *Melchert & Sorensen* 6207 & 6207*B* (IA); 12 mi. S. of Jacala, *Melchert & Sorensen* 6208 (IA); between Zacualtipán and Olotlá, *Moore* 3292 (GH); along route 105 by Río Panotlán, *Moore* 5330 (BH, GH, UC); near Ixmiquilpan, *Rose et al.* 9158 (GH); K-257, N. of Zimapán, *Schnooberger* 8002 (MICH). QUERETARO: 15 mi. SE. of San Juan del Río, *Waterfall & Wallis*

13966 (IA). GUANAJUATO: along road between Guanajuato and Dolores Hidalgo, *Johnston & Ettlinger* 2634*A* (TEX), *Kenoyer* 2111 (GH), *Moore & Wood* 4787 (BH). JALISCO: slopes and ledges in the Barranca del Río Verde (locally known also as Río Blanco), *Detling* 8512 (MICH), *McVaugh* 17342 (MICH), *Melchert & Sorensen* 6063 *A-L* (IA), 6066 (IA); slopes of Nevado de Colima (Volcán Fuego), *McVaugh* 13495 (MICH), 13555 (MICH), *Melchert et al.* 6393 (IA), *Urbina s.n.* (MEXU); 5-8 mi. W. of Los Volcanes along road to Puerto Vallarta, *Melchert et al.* 6382 *A-F* (IA), 6383 (IA); near Guadalajara, *Chisholm s.n.* (MEXU); cliffs of Cerro de Talcozagua, *Iltis et al.* 707 (MEXU, MICH, NY, TEX, WIS); Cerro del Tigre, 3 mi. S. of Mazamitla, *McVaugh* 12967 (MICH), 12972 (MICH); SW. of Ojuelos along road to Aguascalientes, *McVaugh* 16762 (MICH); 15 mi. WSW. of Ojuelos, *McVaugh* 17015 (MICH); E. slopes of Cerro de los Gallos, *McVaugh* 17087 (MICH); SE. slopes of Cerro Gordo above San Ignacio, *McVaugh* 17504 (MICH); barranca 5 mi. SW. of Tecalitlán, *McVaugh* 18129 (MICH); 2 mi. NW. of Tequila, *McVaugh* 18624 (MICH); Cerro del Halo along road to San Isidro, *McVaugh & Koelz* 1250 (MICH); 20 mi. E. of Ixtlán del Río, Nayarit, along route 15, *Melchert et al.* 6335 (IA); near summit of Cerro Etzatlán, *Melchert et al.* 6357 *A-I* (IA); 8 mi. N. of Ciudad Guzman along road from Sayula, *Melchert et al.* 6391 (IA); 15 mi. S. of Mazamitla along route 110, *Melchert et al.* 6399 (IA); between Mesquitec and Monte Escobedo, *Rose* 2622 (GH, US); between Bolaños and Guadalajara, *Rose* 3018 (US), 3085 (US); 15 mi. SE. of Autlán, *Wilbur & Wilbur* 1967 (MICH, US), 2016 (MICH, US). AGUASCALIENTES: Cerro del Laurel about 10 mi. SE. of Calvillo, *McVaugh* 18423 (MICH). NAYARIT: 9-16 m. W. of Tepíc along route 15, *McVaugh* 18927 (MICH), 18938 (MICH), *Melchert & Sorensen* 6327 (IA); along road S. of Tepíc to Compostela, *McVaugh* 16422 (MICH), *Melchert et al.* 6328 (IA); 3.5 mi. NW. of Ahuacatlán, *Feddema* 423 (MICH); slopes above lake NE. of Santa María del Oro, *Feddema* 699 (MICH), 730 (MICH); SW. slopes of Cerro Sangangüey, *Feddema* 914 (MICH); 20 mi. W. of Ahuacatlán along route 15, *Melchert et al.* 6330 *A-C & pop* (IA); along road from Tepíc to Jalcojotán, *Mexia* 605 (CAS, F, GH, MO, NY, UC, US); between Dolores and Santa Gertrudis, *Rose* 2036 (US). VERACRUZ: San Miguel to La Joya, *Balls* B5491 (UC); Tlalcolulán, near Piletas, *Dodds* 104 (MICH); about one mile from Jalapa, *MacDaniels* 401 (F); 19 mi. W. of Orizaba along route 150 to Tehuacán, *Melchert & Soresen* 6198 *A-E* (IA); Zacualpán, *Purpus* 1866 (F, MO, UC, US); Puente de San Miguel, *Rangman* 3425 (US); at W. end of Dam above Tuzpango, *Sharp* 441726 (F). PUEBLA: about 3 mi. N. of Atlixco along route 190, *Melchert & Sorensen* 6152 *A-F* (IA); Chila-Zapotitlán, *Miranda* 2838 (MEXU); Amozoc, *Pringle* 9631 (GH, US); vicinity of San Luis Tultitlanapa, *Purpus* 3113 (F); near Tehuacán, *Rose & Hay* 10121 (GH, US); Esperanza, *Seaton* 357 (F,

GH, NY, US); Puente del Emperador, *Sharp* 44525 (F); along Tehuacán-Orizaba highway on slopes below Puerto del Aire, *C. E. Smith et al.* 3895 (F, MEXU, US). TLAXCALA: along route 140, 35 mi. E. of Texcoco, *Montgomery & Root* 9033A (MSC). MEXICO: along route 130 from Toluca to Temascaltepec, *King* 3579 (MICH, NY, TEX, UC, US), *Melchert & Sorensen* 6220 *A-D* (IA), 6221 (IA), 6224 *A-B* (IA); vicinity of Temascaltepec, *Hinton* 2028 (F, MEXU, MO, NY, US), 7965 (GH), 7999 (F, GH, MO, US), *Matuda* 27706 (NY); Valle de Bravo, *Matuda* 27195 (MEXU), *Melchert et al.* 6431 (IA), *Moore & Cetto* 5482 (BH, GH, UC); vicinity of Ixtapán de la Sal along route 55, *Mick & Roe* 350 (WIS), *Paray* 2769 (MEXU), *Roe & Roe* 1889 (A, WIS); vicinity of Villa Guerrero along route 55, *Melchert et al.* 6490 (IA), *Roe & Roe* 1840 (A, WIS); Santa Fé, Cuajimalpa, *Matuda* 21395 (MEXU, NY), *Salasar s.n.* (MEXU); S. side of Guadalupe dam, *Corzo & Guzman* 9 Aug. 1963 (MICH, TEX, WIS); near Huisquilnango, *Matuda* 21091 (MEXU); Tepotzotlán, *Matuda* 21714 (NY); near Santo Tomás, *Matuda* 27124, (MEXU); Villa de Allende, *Matuda* 27646 (MEXU, NY); near Huehuetoca, *Matuda* 29079 (MEXU); Cerro Jilotepec, *Matuda* 29118 (NY); Real de Abajo near Sultepec, *Matuda* 29289 (NY); Cerro de los Capulines, *Matuda* 31343 (US); 9 mi. S. of Tenango, *Melchert & Sorensen* 6122 *A-D* (IA); 16 mi. S. of Tenancingo along route 55, *Melchert & Sorensen* 6129 *A-C* (IA); 7 mi. S. of Atlalcomulco along route 55, *Melchert & Sorensen* 6231 (IA); 1 km. SE. of Cahuacán, *Montoya* 51 (TEX); 8 km. SW. of Luvianos along road to Nanchititla, *Rzedowski* 20735 (MEXU). DISTRITO FEDERAL: Pedregal de San Angel, *Barkely & Paxson* 515 (F, MEXU, MICH, TEX), *Martinez s.n.* 14 Aug. 1959 (MEXU), *Matuda* 19484 (MEXU), *Mexia* 2730 (CAS, MICH, NY, UC); lava beds between México City & Cuernavaca along route 95, *Degener & Degener* 26267 (F), *Matuda* 21357 (NY), 21283 (NY, UC), *Strother* 498 (TEX); near Eslaba (Eslava), *Pringle* 11510 (CAS, F, GH, MICH, US), *Rusby* 378 (NY, US), 379 (NY, US), 380 (NY, US), 381 (NY, US), 382 (NY); pedregal near Ajusco; *Matuda* 19168 (MEXU); Lomas de Chapultepec, *Martinez s.n.* 1 Oct. 1954 (MEXU). MORELOS: near Cuernavaca, *MacDaniels* 281 (F), *Matuda* 21470 (NY); El Tezcal, 9 km. SW. of Tepoxtlán, *Clausen* 313 (MEXU, NY); Valle de Tepeite, *Lyonnet* 2416 (US), about 8 mi. SSW. of Tres Cumbres on road to Zempoala, *Melchert & Sorensen* 6107 (IA); 10 mi. N. of Cuernavaca, *Melchert et al.* 6487 (IA). MICHOACAN: numerous localities between Morelia and Ciudad Hidalgo along route 15, *King* 3613 (DS, MICH, NY, TEX, US), 3614 (DS, MEXU, MICH, NY, TEX, UC, US), 3619 (TEX), *Melchert & Sorensen* 6089 *A-G* (IA), 6091 (IA), 6095 *A-K* (IA), 6096 *A-K* (IA), 6097 (IA), *Melchert et al.* 6412 (IA), 6417 (IA), 6426 (IA), 6427 (IA), *Ugent & Flores* 1712 (WIS); 1745 (WIS); along route 15 E. of Zacapu, *Iltis et al.* 435 (TEX, WIS), *Melchert et al.* 6409 (IA), 6410 (IA); vicinity of Cerro Tancítaro and Apatzingán, *Hinton*

15257 (F, GH, MO), *Leavenworth* 590 (F, NY), 640 (F, GH); district of Coalcomán, *Hinton* 12266 (GH, MICH, NY, UC, US), 15936 (NY), 15954 (NY); along route 37 S. of Uruapán, *King & Soderstrom* 4739 (MICH, NY, TEX, UC, US), *Melchert & Sorensen* 6081 (IA); 5 mi. N. of Pátzcuaro, *Barkley et al.* 2702 (F, TEX); 5.5 mi. N. of San Pedro Jacuro on road to San Andres, *Beaman* 4260 *A-C* (GH, MSC, TEX); Cerro Santa María, 8-10 km. SW. of Jiquilpán, *Feddema* 200 (MICH), 205 (MICH); cañon 2 mi. N. of Zitácuaro, *Hitchcock & Stanford* 7206 (DS, POM, UC); 12 mi. NW. of Zitácuaro, *King* 3604 (DS, MEXU, MICH, NY, TEX, UC, US); near Cojumatlán, *Melchert & Sorensen* 6073 (IA); 32 mi. E. of Zamora, *Melchert & Sorensen* 6075 *A-D* (IA); 15 mi. N. of Cherán along route 37, *Melchert & Sorensen* 6076A (IA); 3 mi. S. of Escalante along route 160, *Melchert & Sorensen* 6086 *A-K* (IA); 6 m. E. of Tuzpán, *Melchert & Sorensen* 6102 (IA); 5 mi. W. of Jacona, *Melchert et al.* 6400 *A-B* (IA); 6.4 km. NE. of Pátzcuaro on the road to Zurumútaro, *Ugent & Flores* 2115 (WIS). CHIAPAS: in the vicinity of San Cristóbal de las Casas, *Breedlove* 11342 (DS), 11905 (DS), *Melchert et al.* 6459 (IA); along trail from Tenejapa to Paraiso, *Breedlove* 6813 (DS, F, MICH); 3 mi. W. of Huistán, *Breedlove* 12413 (DS); barrio of Tuk, paraje of Matsab, *Breedlove* 12510 (DS, MEXU); along trail from Tenejapa to Colonia San Antonio, *Breedlove* 12798 (DS); Miramar, *Matuda* 785 (MEXU, MICH); Puerto Arriba, *Miranda* 7261 (MEXU); Cerro del Boqueron (Cerro Ovando), *Purpus* 6667 (F, MO, NY, UC). OAXACA: along route 175 N. of Oaxaca to Ixtlán de Juárez, *King* 3511 (MICH, TEX), *Melchert & Sorensen* 6170 (IA), 6172 (IA); vicinity of Cerro Zempoaltepetl, *Hallberg* 1061 (MICH); Monte Alban, *Kenoyer* 1522 (GH); about 24 mi. N. of Oaxaca along route 190, *King* 3520 (TEX); 10 mi. S. of Huajuapán, *Melchert & Sorensen* 6156 *A-E* (IA). GUERRERO: vicinity of Taxco, *Abbott* 147 (GH), 396 (GH), *Manning & Manning* 531012 (GH); along road from Chilpancingo E. to Tixtla, *Melchert & Sorensen* 6136 (IA), 6143 *A-B* (IA), 6143 *A-B* (IA), 6146 (IA); District of Minas, *Hinton* 9221 (GH, MICH, NY, UC, US), *Hinton* 14496 (GH, MO, NY, US); district of Montes de Oca, *Hinton* 11350 (GH, MICH, NY, UC, US); Cañon de Zopilote between Mexcala and Zumpango along route 95, *Moore* 5197 (BH); 3 km. beyond Acahuizotla along road to Acapulco, *Moore & Wood* 4676 (BH, UC); about 24 mi. S. of Chilpancingo along route 95, *Melchert & Sorensen* 6131 *A-C* (IA); 6 mi. N. of Ocotito along route 95, *Melchert & Sorensen* 6133 *A-E* (IA); Cañon de la Mano near Iguala, *Rose et al.* 9330 (GH, US). GUATEMALA. BAJA VERAPAZ: 14 mi. N. of Salama along route 5, *King* 3356 (TEX). CHIMATENANGO: near Tecpán, *White* 5264 (F, MICH). HUEHUETENANGO: about 11 mi. S. of Huehuetenango along route 9N, *King* 3390 (MICH, NY, TEX, UC, US); between Sololá and Santa Eulalia, *Steyermark*

49971 (F); between Chemal and Calaveras, *Steyermark* 50341 (F, GH); Cerro Pixpix above San Ildefonso Ixtlahuacán, *Steyermark* 50607 (F, NY); 2/3 of way up Cerro Chiquihui above Carrizal, *Steyermark* 50789 (F); mtns. across river from San Juan Atitán, *Steyermark* 51976 (F). JALAPA: between Jalapa and Montaña Miramundo, *Steyermark* 32864 (F). QUETZALTENANGO: fields along route 1 about 3 mi. E. of Quetzaltenango, *King* 3204 (MICH, TEX, UC). SACATEPEQUEZ: slopes of Volcán de Agua N. of Santa María de Jesús, *Standley* 59373 (F). SOLOLA: along route 1 between Sclolá and Panajachel, *King* 3231 (TEX), *Melchert et al.* 6438 (IA). TOTONICAPAN: in San Cristóbal Totonicapán, *Breedlove* 11465 (DS). ZACAPA: ravine along Río Lima between Río Hondo and summit of Cerro Finca Alejandria, *Steyermark* 29613 (F).

Dahlia coccinea is perhaps the most complex species of the genus. Its characteristics are nearly all superlative. It has the greatest geographic range (see Map 8), the greatest amount of variation in its foliar and floral features, perhaps the showiest "flowers," and is the only *Dahlia* which might be called a weed. The great range of variation in nearly all its characteristics, as portrayed in the foregoing description, has not gone unnoticed by previous workers. Sherff (1955), attempting to make some taxonomic "sense" of the species, established the following four varieties:

1. var. *steyermarkii*, simple to irregularly 1-pinnate leaves, usually coarse-textured, stems subvillous or tomentulose.
2. var. *coccinea*, leaves 1- or 2-pinnate, regularly divided, stems glabrous or nearly so.
3. var. *palmeri*, leaves 2- or 3-pinnate, stems robust, reddish-glaucous, ligules orange or scarlet.
4. var. *gentryi*, leaves 2- or 3-pinnate, stems delicate, straw-colored, ligules yellow.

It is my belief that *D. coccinea* is a *single*, very wide-ranging, polymorphic species and that its "varieties" are often merely extreme variants which arise independently within geographically distinct (but not necessarily reproductively isolated) breeding populations. In the course of this study I have encountered these "varieties" in the field and have made certain observations about them and about the species as a whole. These are listed below with certain

facts obtained from subsequent laboratory studies of my collections.

a) The "variety" to which an individual plant belongs, unless its features are extreme, is difficult, if not impossible, to determine.

b) The geographic range of each variety is sympatric with one or more of the other varieties.

c) In several populations two of these varieties (not always the same two) were growing side by side, sometimes with intermediate forms between them (cf. *Melchert et al.* 6318 *A & B*, 6357 *A-E*, & 6409).

d) All the varieties occupy more or less the same type of habitat.

e) In most populations ligule color, leaf shape and size, chromosome number, height, and other features vary independently. For example, a population of scarlet rayed plants may have leaves ranging from irregularly-pinnatifid (var. *steyermarkii*) to tri-pinnate (var. *palmeri*) (cf. *Melchert et al.* 6382 & 6383).

f) Although diploid and tetraploid races are sympatric throughout most of the range of the species, the tetraploid races extend farther southeast into Guatemala. In several localities populations of the two races were found within a mile or two of one another but were normally not contiguous except as noted below.

g) In one instance both diploids and tetraploids were found in the same population. These plants were morphologically similar and were found growing within a few feet of one another (cf. *Melchert & Sorensen* 6063 *A-F*).

h) Many diploids and tetraploids throughout most of the range of the species are morphologically indistinguishable.

i) Several of the populations discovered in remote places and isolated from the main body of the species (cf. *Melchert et al.* 6280 & 6393) turned out to be diploids. All of the tetraploids were found in disturbed areas along roadsides and fields as were also some of the diploids.

Dahlia coccinea, as with most *Dahlia* species, is repro-

ductively self-incompatible. This has been true of five individuals, 3 of them diploids and 2 tetraploids, which I have grown in the greenhouse from tubers collected in México. In cases where this form of barrier to inbreeding prevails a high degree of heterozygosity is maintained in the population and all plants of each generation are, in a sense, "hybrids." Each of these "hybrids" contains two, or the segments of two or more, genomes allowing for a tremendous amount of stored variability. Such reproductive self-incompatibility in combination with a high percentage of heterozygosity provides for a full exploration of the genotypic and phenotypic potential of any given breeding population in *each* generation. Obviously, not every genotype can survive, and the habitat does not seem to be strongly selective in its choice of those which are allowed to survive (items c & d above). In small populations, therefore, there is an abrupt difference from plant to plant in those characteristics used to determine the varieties. Lacking intermediates their identification becomes a relatively simple matter. On the other hand, if this breeding unit or population is very large, the range of variability is more apt to be continuous. Obviously, in such cases it becomes biologically unsound and taxonomically artificial to designate a few of the specimens "varieties" *gentryi*, *steyermarkii* or *palmeri* and then name all the remaining variants var. *coccinea*. Therefore, my argument until now has been from the viewpoint that the extreme variants of *D. coccinea* should not be given formal taxonomic recognition but should be regarded as segments of a broad morphological spectrum.

On the other hand, I do not wish to create the impression that every discrete population of *D. coccinea* is a mass of morphologically diverse individuals. I have observed certain populations in which there is great uniformity. For example, five miles west of Durango, in the general vicinity of the type locality of *D. coccinea* var. *palmeri*, an isolated population was found at the head end of a box canyon. Of those collected (*Melchert et al.* 6280 *A*, *B* & *pop.*), each

plant was morphologically similar with scarlet rays and 3-pinnate leaves, and they fit Sherff's var. *palmeri* quite well. The single chromosome count obtained was $n = 16$. Again, about 12 miles northwest of Pachuca, Hidalgo, a population (*Melchert & Sorensen* 6203 *A-F*) of the diploid plants was found growing among thorny scrub and cactus plants in a region of semi-desert. All plants had glabrous, bipinnate leaves and unusually large, deep-orange or orange-scarlet ligules. This population was also quite isolated from other populations of *D. coccinea*.

Both of the above examples by themselves possess all of the requirements for varietal status. They are geographically limited, have mutually exclusive morphologic markers and are isolated, at least locally, from the main body of the species. If these populations were all that existed of *D. coccinea* they might even be regarded as distinct species.

It is my opinion that such units with morphologic and geographic uniformity, as described in the above examples, do exist within *D. coccinea*. The problem has been that, until now, the overwhelming majority of the specimens in herbaria are from inhabited areas and from near railroads and along roadsides. What will be needed in order to search out these units is much more collecting from remote, undisturbed and reproductively isolated populations.

The many morphological variants of *Dahlia coccinea* are held together as a species primarily on the basis of their ligule color (item e, above). There is a very limited amount of biochemical evidence in support of this. Five individual plants of *D. coccinea* under greenhouse cultivation from tubers collected in México by *Melchert & Sorensen* during 1965 and 1966 produced heads with ligule colors as follows: 6086, yellow-orange; 6203, deep-orange; 6220, bright scarlet with yellow at base; 6224, yellow-orange; 6318, deep-scarlet. Utilizing 2-dimensional paper chromatography, biochemical profiles of the flavonoid compounds in the ligules of these plants were obtained as follows: the pigments were extracted from freshly collected rays by placing them in a flask with acidified methanol (0.5% conc.

HCl by volume). After 12-20 hours of agitation the extract was condensed and spotted on Whatman No. 3 filter paper. The chromatograms were developed via descending chromatographic techniques. The solvent for the first run consisted of tertiary butyl alcohol: glacial acetic acid: water (3:1:1 v/v) and for the second run in the second dimension, 15% by volume of glacial acetic acid and water. When the chromatograms were dried they were viewed in UV light both with and without ammonia fumes. An essentially identical basic profile involving 8 compounds (3 visible as yellow in daylight, 5 visible only in UV) were found in each sample. An additional compound, probably an anthocyanin (visible as magenta in daylight), was found in varying quantities on some and absent on others.

An identical test was made of the ligules of three other species which produced light purple ligules in various shades. The profile of these was quite unlike that of *D. coccinea* rays.

On the basis of these exceedingly preliminary and qualitative data it is concluded that the varying colors of intact rays of *D. coccinea* heads are due to differing concentrations of anthocyanin. Underlying the variable anthocyanin pigment, however, there is, uniformly present throughout the species, a basic group of 8 compounds. Several of these apparently contribute very little to the visible color of the rays but, interestingly, are strikingly different from the basic profile seen in ligules of the purple-rayed species.

In summary, *Dahlia coccinea* is a wide-ranging, polymorphic species. The species is held together by its ray colors which range from lemon yellow to deep blackish-scarlet and by the absence of clear morphologic discontinuities in the great range of variation displayed by its vegetative parts. For the present, it appears best not to recognize any formal subspecific taxa, but it is expected that eventually some could be established. This must await the accumulation of a much greater amount of information on the morphology, cytology, and geographic distribution of the species and of its various morpho-geograhic units.

Doubtful, Excluded and Rejected Names

Dahlia acutiflora DC. Prodr. **5:** 494. 1836. This name is listed by de Candolle as a synonym for *Dahlia cervantesii* (Lagasca ex Sweet) DC. (i.e. *Dahlia coccinea* Cav.) however, he remarks that the ligule colors range from purple to scarlet which suggests it was of hybrid origin.

Dahlia astrantiaeflora (Sweet) G. Don in Sweet's Hortus Brit. ed. 3, 353. 1839. This should be regarded as a cultivar.

Dahlia fulgens Hort. ex Sweet, Brit. Fl. Gard: 282. 1829. Sweet offers this name as a synonym for *Georgina crocata* (Sessé ex Lagasca) Sweet (i.e. *Dahlia coccinea* Cav.) without reference to its earlier publication. As nearly as I can determine this is its first appearance in the literature.

Dahlia gigantea Bull. in Loudon, Ladies' Flower-Garden **2:** 6. 1844. *Nomen nudum.*

Dahlia juarezii Van der Berg, Gard. Chron. II. **12:** 433, *fig. 66.* 1879. and *Ibid.* 594. 1879. This name has been widely used in reference to all *Dahlia* hybrids which produce revolute rays. As noted in the second reference of 1879 above, the original plant which served as the progenitor of these hybrids may have been referable to *Dahlia coccinea* Cav.

Dahlia platylepis A. Brongn. ex Neumann, Rev. Hort. II. **4:** 305. 1845. The description accompanying this name is confusing and cannot be related to any known taxon. The height of the plant is given as 3 m. suggesting that it might be referable to a species of section Pseudodendron but the petiole measurements given as 10-12 cm. would exclude those taxa.

Dahlia pubescens A. Brongn. ex Neumann, Rev. Hort. II. **4:** 305. 1845. Apparently Brongniart intended this name to refer to a segregate of *Dahlia platylepis* with the same description applying to both names. The added remarks that *Dahlia pubescens* had more hairy leaf surfaces is no help in relating it to a known taxon.

Dahlia purpurea Cav. in Desfontaines, Tab. de l'Ecole

Bot. Mus. Hist. Nat. Paris. 106. 1804. The epithet is that of Thouin (1804) but Desfontaines attributes it to Cavanilles without reference to its publication.

Dahlia pusilla in Herb. Zucc. ex DC. Prodr. **5:** 494. 1836. This name was apparently regarded by de Candolle as a synonym for a horticultural variant of *Dahlia variabilis* (Willd.) Desf. It should be regarded as a cultivar.

Dahlia repens Hartweg in litt. ex Benth. Trans. Hort. Soc. London II. **2:** 395. 1840. *Nomen nudum.*

Dahlia repens Hort. ex Verlot, Rev. Hort. **1864:** 31. 1864. *Nomen nudum.* It is not known whether there is any connection at all between the *Dahlia repens* referred to by Verlot and the species given the same name by Hartweg above.

Dahlia rosea Cav. Icones et Descr. Pl. **3:** 33, *t. 265.* 1796. This name has been a source of constant error and, in accordance with the provision of Art. 69, *International Code of Botanical Nomenclature.* 1966, should be rejected. Many authors have considered it a synonym of *Dahlia pinnata* Cav. (or of some nomenclatural equivalent of *Dahlia pinnata*) while others have related it to the "tree-Dahlias". In the original description the phrase "pinnulis secondariis nunc alternis, nunc oppositis" suggests it may be an earlier name for what is treated here as *Dahlia merckii* Lehm. However, later authors such as Thouin and de Candolle who had access to plants grown from the seeds of the original study material of Cavanilles do not mention this trait.

Dahlia royleana Knowles & Westc. Fl. Cab. **3:** 186. 1840. Description inadequate.

Dahlia sphondyliifolia Salisb. Trans. Roy. Hort. Soc. **1:** 91. 1820. This is a superfluous name apparently offered by Salisbury as a more descriptive epithet for *Dahlia rosea* Cav. noted above.

Dahlia zimapani Roezl in litt. ex Ortgies, Gartenflora **1861:** 406, *t. 347.* 1861. = Cosmos diversifolius Otto.

Georgina astrantiaeflora Sweet, Hortus Brit. ed. 2. p. 310. 1830. This should be regarded as a cultivar.

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Georgina petroselinifolia Liebmann in litt. Bot. Zeit. **2**: 687 & 734. 1844. *Nomen nudum.*

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WINTERBUD PRODUCTION AND FUNCTION IN BRASENIA SCHREBERI

FRANKLIN S. ADAMS[1]

Propagule-like reproductive structures are regularly found among many of the higher aquatic Angiosperms. When such structures are dormant overwinter and germinate in the spring to produce new plants, they are generally called winterbuds. (fig. 1.) In cases where the complete life cycles of these plants have been observed, it can be reasonably said that asexual vegetative reproduction through winterbud production and dissemination plays a significant role in the seasonal maintenance and distribution of these higher aquatic plants (Arber 1963, Sculthorpe 1967). One such plant receiving only limited attention in the literature is *Brasenia Schreberi* Gmel., which produces large highly developed winterbuds (Arber 1963, Chrysler 1938) or turions (hibernacula) (Sculthorpe 1967). (fig. 3-a.)

The genus *Brasenia* is a monotypic aquatic group in the family Nymphaeaceae belonging in the subfamily Cabomboideae, the closest living relative is the genus *Cabomba*. *Brasenia* is distributed throughout the world in the temperate zones and the higher elevations of the subtropics with the exception of continental Europe. However, fossil evidence indicates that *Brasenia* grew widely throughout Europe during the Pleistocene period (Arber 1963, Engler and Prantl 1891, Fassett 1957, Ridley 1930).

No comprehensive study of the life history or ecological treatment of the genus *Brasenia* exists. Early anatomical data are available however (Schrenk 1888). In addition, Chrysler in 1938 published a limited account of the function of winterbuds of *Brasenia* based upon field observations in

[1]This study was conducted while the author was an NDEA Graduate Fellow at the University of New Hampshire. I should like to express my gratitude to Mr. Wendell Berry, who, as a graduate student at U.N.H., assisted immeasurably in the early stages of this study. Special thanks are also due to Professors Albion R. Hodgdon and Radcliffe B. Pike for their generous assistance and encouragement throughout.

P
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southern Maine and laboratory experiments conducted in New Jersey with the material from Maine. Briefly, Chrysler suggests that *Brasenia* winterbuds abscise in the fall and by remaining dormant on the bottom of the pond overwinter and germinate in the spring thereby fulfilling an important reproductive function.

In a review of the aquatic Angiosperms Arber in 1963, based at least in part upon the work of Chrysler (1938), states that winterbuds of *Brasenia* are specialized structures of reproduction. In addition, Yeo in 1966, in a utilitarian study of yields of winterbuds found in the commercial water of the western Rockies and California, has reached essentially the same conclusions based upon yield data and literature references. Most recently, Sculthorpe (1967), also citing Chrysler, has provided a most convincing description of *Brasenia* winterbud (turion) production and function.

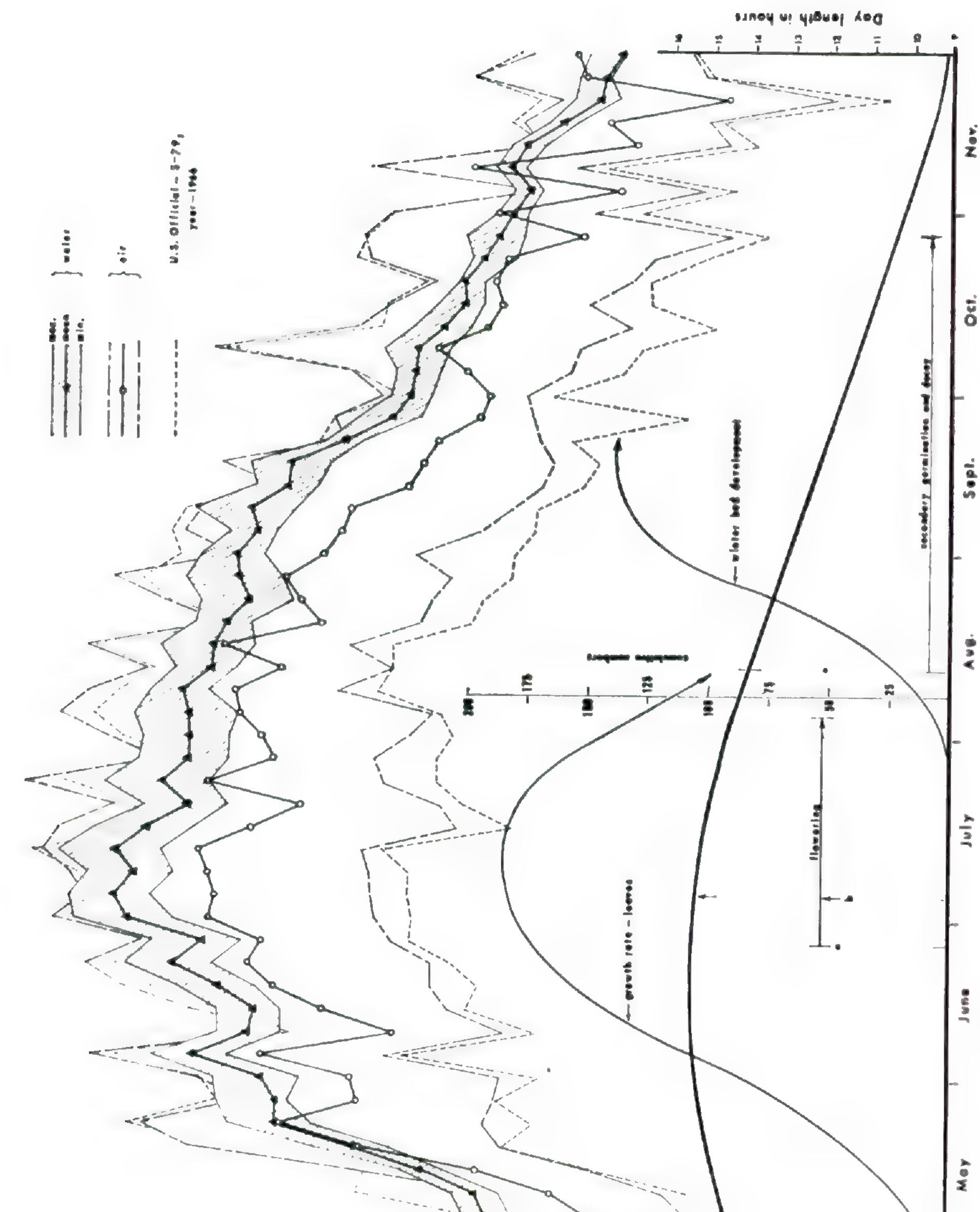
Conversely, preliminary observations conducted by the author during the 1965 season in east-central New Hampshire suggested that *Brasenia* winterbuds are not effective reproduction structures, at least at this latitude and longitude. Thus it is this question of functional vegetative propagation via winterbud production and dissemination casually observed and reported by Chrysler that the present paper attempts to resolve.

With the foregoing objective clearly defined, the task of designing an adequate research program was simplified. In order to satisfactorily understand the function of *Brasenia* winterbuds, all events that constitute the so-called "normal" life cycle of the plant would have to be routinely observed and recorded.

Two observational sites were selected on the bases of accessibility and differing ecological characteristics. One,

Plate 1424

Figure 1. Functional winterbuds of several aquatic vascular plants. a. *Ceratophyllum demersum* L. b. *Elodea Nuttallii* (Planch) St. John. c. *Utricularia vulgaris* L. d. *Utricularia* pupurea Walt. e. *Vallisneria americana* Michx.


BRASENIA GROWTH IN RELATION TO ENVIRONMENTAL FACTORS
Day length in hours
Temperature
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
water
air
U.S. Official – 5-79, year – 1966
water bed development
growth rate – leaves
flowering
secondary germination and decay

Wheelwright Pond in Lee, New Hampshire: of moderate size, 100+ acres; of varying depth, one to thirty feet; of pH 6.8 to 7.4 depending upon the time of year, was selected as the primary site. Four observation stations were established which provided the bulk of the quantitative data reported herein.

The second site in Nottingham, New Hampshire on the first branch of the Little River is a small beaver dam and pond: of approximately four acres in size; of relatively uniform depth, two to eight feet; surrounded by a sphagnum swamp at the margins; of relatively acid composition, approaching pH 5.0 at times of low water, was used primarily as a confirmation station. In addition, it was possible to follow the course of winterbud distribution for several miles downstream and, most importantly, to record their fate.

Typical life history growth phenomena were observed and recorded with time throughout the 1966 growing season which included: initiation of growth; growth rates; flowering; winterbud initiation and productivity; winterbud distribution and postseasonal development including ultimate fate. Equated to temperature and photoperiod, the combined data for Wheelwright Pond are summarized in figure 2 and explained below.

A total of 10 *Brasenia* plants, selected at random within site #1, were individually identified with a tagged stake thrust securely into the bottom muck adjacent to each plant. The individual plants possessed from one to three attached winterbuds consisting of from one to three segments. (see fig. 3 and 4) Daily observations were made during the period April 11 to April 30. Initiation of growth as "germination" was recorded as having occurred when the first

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Figure 2. Summary graphical representation in time of various growth phenomena associated with the life cycle of *Brasenia Schreberi* Gmel. at Wheelwright Pond, Lee, New Hampshire, during the 1966 growing season. The phenomena of growth have been equated with temperature and photoperiod (day length) at this latitude, 43° 08′ North and Longitude, 71° 00′ West. Detailed explanation in text.

observable meristem of a winterbud was measured to have elongated one inch. Of the ten plants observed, only one failed to grow, the remaining nine plants germinated within a two day period, April 24 and 25. The process of germination was confirmed at the three remaining Wheelwright stations and Nottingham during the same period.

The initial attempt to determine growth rate as a function of meristem elongation had to be abandoned in the second week. The profusion of leaves being produced throughout the colony made it virtually impossible to relocate tagged structures from one day to the next. The remaining data were obtained as the average daily number of new leaves arriving at the surface within two sample plots, each measuring 40 × 50 feet. At best, the composite curve "growth rate-leaves" can only be presented as an approximation of real growth rates. Despite these inadequacies, the observed data are in general agreement with the literature values for hydrophytes. (Arber 1963, Sculthorpe 1967)

No attempt was made to quantitate flowering. Flowerbud initiation (a), day of flowering (b), and period of flowering are presented as they relate in time to all other observed growth phenomena. (See fig. 2.)

Since all observed active shoot apicies possess a winterbud-like morphology (containing only one segment) at all times during the growing season, it was difficult to determine precisely when initiation of true winterbuds had occurred. When a total of ten such structures were observed to have developed multiple segments, winterbud initiation was assumed to have occurred. Subsequent observations confirmed these decisions.

The curve "winterbud development" corresponds to the total number of winterbuds produced by twenty plants selected at random and observed weekly during the period July 23 to September 28.

In excess of 6,000 winterbuds were counted, examined and collected during the 1966 and 1967 seasons. In the interest of clarity, these data are presented twice. First,

as the events occurred in time (see fig. 2, secondary germination and decay); second, as the events occurred quantitatively (see fig. 5, summary of winterbud activity). The significance of these data is presented in the results and discussion section below.

A "Friez" (Bendix Aviation Corporation) model 201-W dual-recording thermograph provided an accurate accounting of water and air temperatures on a continuous basis at site #1, station #1, Wheelwright Pond. The instrument was housed on a roofed but open-sided platform supported by a fixed tripod and elevated three feet above the surface of the water, twenty-five feet from shore. The air temperature probe was shaded from sun and rain but otherwise exposed to the atmosphere at all times. The remote water temperature probe was located on the shaded side of the north oriented leg of the tripod at a depth of 55 cm., the average depth of attached winterbuds observed at the site at the time of installation.

The temperature data were averaged, means calculated (mean low, mean, mean high), and plotted on the basis of four day intervals for each parameter, water and air. Official U. S. Weather Bureau Station S-79, Durham, New Hampshire, data were averaged and the four day means plotted to indicate the range of differences between atmospheric temperatures over land and water. For convenience, all temperatures are expressed in Fahrenheit.

Photoperiodicity, expressed as "day length in hours," was calculated from official U. S. Coast and Geodetic Survey Sunrise and Sunset Tables (U. S. Department of Commerce 1966) for Boston, Massachusetts, and corrected to Latitude 43° 08′ North and Longitude 71° 00′ West, the geographical location of Wheelwright Pond.

An experiment designed to test the winterbud's ability to germinate in relation to water depth was conducted at the Wheelwright Pond Site #1. A long upright stake was driven securely into the bottom muck in nine feet of water. At two foot intervals from the surface downward were attached four 6″ × 8″ perforated cans with clear polyethy-

lene covers containing three winterbuds each; the cans were arranged vertically along the south-facing side of the stake. The entire apparatus was installed in place on December 2, 1965 and retained throughout the winter and spring seasons. Surface observations were made weekly throughout and the winterbuds collected on June 11, 1966. (See fig. 4.)

An experiment designed to test the effectiveness of the winterbud as a reproductive propagule was conducted at the Wheelwright Pond Site #1, during the 1966 season and early 1967. First, 20 ungerminated winterbuds were secured to separate six foot segments of light cotton string and tethered individually to stakes scattered throughout the area in water depths ranging from 1 to 5 feet. Second, several hundred detached ungerminated winterbuds were liberated in the same areas and their progress followed daily for several weeks and weekly thereafter. Attempts to attach identifying markers restricted their free movement and were abandoned. Consequently, it was possible to observe accurately fewer than twenty-five of the total number released. Nevertheless, the results proved uniform throughout. In total, over 400 individual observations were made on a daily or weekly basis throughout the period of this study.

A 4 × 6 × 4 foot aerated aquatics tank was established in the University greenhouse for the purpose of observing the phenomenon of winterbud germination under controlled conditions particularly in response to freezing. Despite certain difficulties in controlling the growth of undesirable algae, useful data were obtained; winterbuds subjected to freezing failed to germinate.

DISCUSSION

All terminal growth, including lateral growth of the rhizome exclusive of the roots, is mediated by complex structures resembling winterbuds at all times during the year. The only obvious morphological difference between actively growing meristems and dormant winterbud struc-

tures involves size and complexity. Terminal growing points are less than 3 cm. in length and possess one lateral leaf, one shoot tip and one primordia of each meristem at any point in time. The dormant structures are essentially multiples of these, thickened transversely and containing up to ten distinct subunits arranged sequentially and/or laterally and varying in length from 3 cm. to a maximum of greater than 20 cm. Furthermore, the overwintering rhizome is tipped by a winterbud which is larger than those found during the growing season and smaller than most found at the tips of shoots in the fall. Significant anatomical and cytological differences between these unique structures are suspected based upon preliminary examinations.

Although *Brasenia* colonies are perennial, no single individual will be more than one season old; no segment of a rhizome will be more than two seasons old. Attempts to isolate the decay organisms which assist this process were inconclusive.

Winterbuds can and do germinate. However, there are limitations imposed upon such germinations by the environment. The ability of winterbuds to germinate successfully is affected by water depth. The compensation depth, beyond which germination is incomplete, lies between six and seven feet within the conditions encountered in this study. (See fig. 4) The extent to which leaf, shoot, and root development is affected by depth is pronounced, however, the physiological significance of such differences has not been investigated.

Winterbuds can not withstand freezing. In every case, the slightest degree of freezing involving meristematic tissues precluded germination.

The first winterbuds that were clearly destined to become overwintering structures were collected on July 30, 1966. The ultimate fate of such structures varied widely and is summarized in figure 5. For convenience (according to their fate within the conditions encountered by this study) it is possible to divide the production of winterbuds into two categories: (1) winterbuds maturing prior to 1 Octo-

ber; and (2) winterbuds maturing after 1 October. The number of winterbuds counted and observed in each category exceeds 2,500.

Winterbuds, despite the presence of an abscission-like layer at the base (Schrenk 1888, confirmed by Chrysler 1938), have not been observed to absise in the way the presence of such a structure would suggest. Abscission, other than in response to external forces, occurs naturally in response to decay of the upright stem portion near the rhizome. The largest and most complex winterbuds were collected as free-floating plant portions prior to October 1 (60% of the total production). Conversely, all winterbuds maturing after 1 October, remained attached to the parent plant unless forcibly removed (40% of the total production). With few exceptions, leaf abscission appears to function normally in both the attached and free-floating conditions. The differences between normal leaf abscission and abnormal winterbud abscission suggest the presence of a special winterbud abscission mechanism.

Fate of winterbuds associated with free-floating plant parts: All at first float. All floating winterbuds sank when their mucilage covering was reduced by approximately one half. As the temperature of the water decreased during this period, the time required for the mucilage covering to be reduced increased and the winterbuds floated longer. The sunken winterbuds either germinated and then decayed or decayed directly without visible signs of germination having occurred (fig. 2, secondary germination and fig. 3, b-c). It is probably significant that secondary (precocious) germination occurred in the fall at the same time, day-length, when germination occurred in the spring. Small groups of these partially decayed winterbuds were observed

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Plate 1425

Figure 3. Winterbud structures of *Brasenia Schreberi* Gmel., illustrating the phenomena of precocious germination and decay. a. typical attached winterbud, b. precocious germination, phase 1., petiole development and elongation of apical meristems, c. precocious germination, phase 2., root development from nodal region, d. early stages of decay, e. advanced stages of decay.

e
d
c
b
a

at shoreline at the time of icing-in. Winter ice conditions would preclude their survival even were the process of decay incomplete, therefore, the natural fate of winter-buds released prior to 1 October is death.

Fate of winterbuds remaining attached to parent plants after 1 October: Forty percent of the total production remained attached as of 1 October. Thirty-five percent of the total production overwintered and in the attached condition provided the source of the next year's growth. (None of the attached winterbuds were observed to germinate precociously in the fall.) Of the 5% accidentally or intentionally released, 4% of the total production were observed to float immediately and remained floating at the margins of the pond at the time of icing-in. All died. One percent, because of entanglement in other submersed vegetation were protected, at least from freezing. It is calculated that fewer than .25% of the total production possessed the potential for survival for the following reasons. (fig. 5.)

Of the many thousands of winterbuds produced in 1965 and observed to germinate in 1966, only eight produced mature plants. These were at the Nottingham site and two were collected and preserved during the summer of 1966. Of the six remaining survivors, only two survived the summer, and neither one was found again in the spring of 1967. Exactly what happened to them is not known. It is conceivable that with the spring thaw the entire plants were torn free and carried away due to their exposed position. Furthermore, the author has never observed well established *Brasenia* plants growing in swift water, not even in occasionally swift water areas.

Additional evidence supports the view that free-floating winterbuds are not effective vegetative reproductive agents.

Plate 1426

Figure 4. Results of detached winterbud germination at various depths, illustrating observable morphological differences and the compensation level below which germination was incomplete. Groups a-d, arranged according to size: $<$ 3 cm, 3-6 cm, $>$ 6 cm, and depth, a. 1 foot, b. 3 feet, c. 5 feet, d. 7 feet.

a
b
c
d

In the case of the tethered winterbuds (see page 424) at the Wheelwright Pond site, all germinated coterminously with the initiation of growth among the attached plants. They did so while sinking and refloating from one to several times, a factor, which if not for their tethered condition would have resulted in their floating into very shallow waters. At best, growth was limited as none of these structures were able to establish roots in the bottom muck due primarily to entanglement with established vegetation. At the end of the 1966 growing season, only one winterbud remained alive; all others had died and decayed.

Similarly, in the case of the released winterbuds, (see page 424) germination occurred as the winterbuds alternately floated and sank. Prevailing westerly winds carried most into shallow water which were then dessicated as the high waters of spring receded. The few winterbuds that survived for longer periods did so through entanglement and ultimately suffered the same fate as the tethered winterbuds.

The Nottingham beaver dam provided an unusual opportunity to witness the phenomena of winterbud germination and ultimate demise en masse. Beaver dam construction facilitates the passage of water through the structure, only in cases of very high water are beaver dams subjected to extensive overflow. Thousands of winterbuds, maturing after 1 October and surviving the winter via entanglement in existing vegetation below the ice, upon release in the spring, floated to the dam and formed an extensive mat approximately one foot thick, thirty feet wide and along the entire eighty foot length of the dam. By mid-July, the waters immediately above the dam were literally obscured by the massive growth of *Brasenia* winterbuds. By September, none remained, all had died and were decaying. The causes underlying this strange behavior have not been investigated. Among several suspected causes are, excessive crowding, competition for nutrients, lack of contact with a favorable substrate and conditions favoring decay. Several trips below the dam for a distance of two miles revealed

no evidence of winterbud survival save the several plants which were previously discussed.

One additional aspect of winterbud behavior needs to be discussed concerning the presence or absence of roots at germination. Free floating winterbuds upon germination always developed roots which emerged from the nodal region from which leaves also develop. Conversely, germinating winterbuds when attached to the parent plant were never observed to form roots. In addition, winterbud-like structures found on the rhizome during the growing season (see page 425) formed roots only following the initiation of upright stems bearing leaves. Cautious speculation suggests the existence of growth substance mediation, probably in the form of an inhibition response.

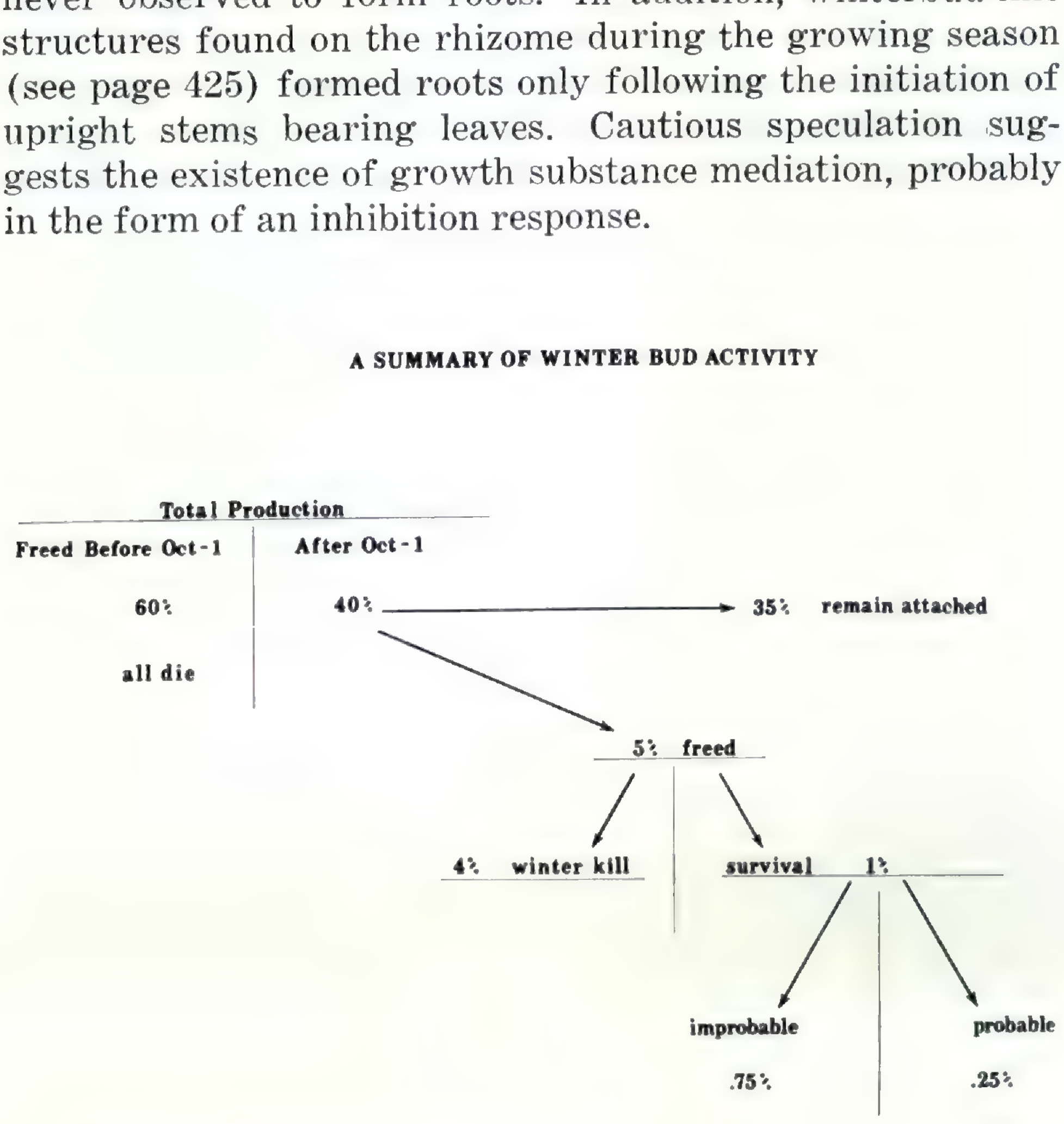

Figure 5. Summary explanation of the fate of winterbuds freed before 1 October, 1966 and those remaining attached to the parent plant or freed following 1 October, 1966. Detailed explanation in text.

SUMMARY

1. In the areas studied, the abscised winterbud structure of *Brasenia Schreberi* Gmel. is, in fact, an ineffective agent of vegetative reproduction.

2. In the areas studied, the attached overwintering winterbud structure is, in fact, absolutely essential for the annual survival of the species.

3. In the areas studied, winterbuds do not:

a. sink immediately upon abscission.

b. overwinter intact on the bottom of the pond.

c. germinate and survive, except rarely when freed.

4. If it can be demonstrated at a future time, in another climate that the winterbud does, in fact, constitute an effective agent for vegetative reproduction, it would be reasonable to conclude that the *Brasenia* winterbud has a positive survival value. Otherwise, the *Brasenia* winterbud must remain an evolutionary enigma — at best an example of Gailbraithian economics, an economy of waste.

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CYPERUS FUSCUS IN NEBRASKA AND SOUTH DAKOTA: Scattered specimens of *Cyperus fuscus* L. were found growing near colonies of *Bidens cernua* L. and *B. comosa* (Gray) Wieg. on the wet open sandy flats of the South Platte River 0.8 mile south of Sutherland, Lincoln County, Nebraska on 24 September 1968 (*Weedon* 4733, KANU). *Cyperus fuscus* L. was also found on the wet sandy clay soil along the bank of the Keya Paha River 17 miles south of Colome, Tripp County, South Dakota on 16 September 1968 (*Stephens* 29293, KANU). *Cyperus fuscus* L. is widespread in Eurasia, especially in rice fields, but appears to be rarely found in the United States. This Umbrella-sedge (galingale) has previously been reported at scattered stations from Massachusetts to western New York and Virginia. Our collections represent extensions westward from the previously known range of the species in the eastern states to areas in the Midwest. Duplicate specimens were verified as to their identification by Dr. R. L. McGregor (KANU) and by Dr. Tetsuo Koyama (NY).

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A SEVENTEENTH CENTURY RECORD FOR STEWARTIA

J. T. Baldwin, Jr.

A population of *Stewartia ovata* (Cav). Weath.[1] is on both sides of the Colonial National Historical Parkway south of Williamsburg, Viginia, from the site of William Parks' paper mill[2] to College (Archers Hope) Creek[3], a distance of about two miles. The plant most likely occurs also to the west of College Creek. As early as 1637 the whole area was being patented and cleared; it now supports a relatively young woods of mixed composition of which in various places *Stewartia* is a striking member. Some individual trees of the genus there reach a height of fifteen feet. Flowers are white, with purple, rose, or yellow filaments (*Baldwin 14951*, GH). Because the stamens are numerous, differences in flower colors are marked.

This population of *Stewartia ovata* is well-known (Grimes, 1922; Kobuski, 1951; Coe, 1959; Harley, 1961; Massey, 1961; Harvill, 1965), but for a second Coastal Plain station in Virginia, in Lancaster County, there is a single report (Harley, 1961). Otherwise, records are for the mountains, hence the name Mountain-Camellia.

We now learn that The Reverend Mr. John Clayton (1657-1725) found the Archers Hope plant in the seven-

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[1]Weatherby (1939) explains that the long-accepted *Stewartia pentagyna* L'Hér. is invalid and that the combination given is necessary.

[2]The mill, dating from 1744, not only supplied the needs of William Parks in Williamsburg but also those of other printers including Benjamin Franklin in Philadelphia.

[3]The colonists landed at the mouth of this creek on May 12, 1607, and proceeded upriver the next day to establish Jamestown. Captain Gabriel Archer advocated settlement at the creek but was outvoted. For more than a century thereafter the creek was known as Archers Hope and was then named for the College of William and Mary. With transfer of the Capital to Williamsburg in 1699 Archer's judgment was vindicated, and just as his creek afforded an approach from the James River to Williamsburg so did Queen's Creek from the York. For a time consideration was given to the construction of a canal to join the two creeks.

teenth century. He arrived in Virginia in May of 1684 to be rector of James City Parish; in May of 1686 he sailed for England, "taking with him some drawings of plants, probably some collections, and certainly a vast fund of information" (Berkeley and Berkeley, 1965). Thereafter he pursued his ministerial work in England and Ireland and followed his natural bent for things scientific. In 1687, in a long letter to Robert Boyle, Clayton wrote an "Account of Virginia", which is a delight to read (Berkeley and Berkeley, 1968); therein, after a picturesque and accurate description of the flowering dogwood, he stated: "I remember near the place caled Coll. Bacons Landing, over agst Archers hope [See Figure 1.], I found a Shrub had a flower like the false flour of this dogg tree only it was a pentape-

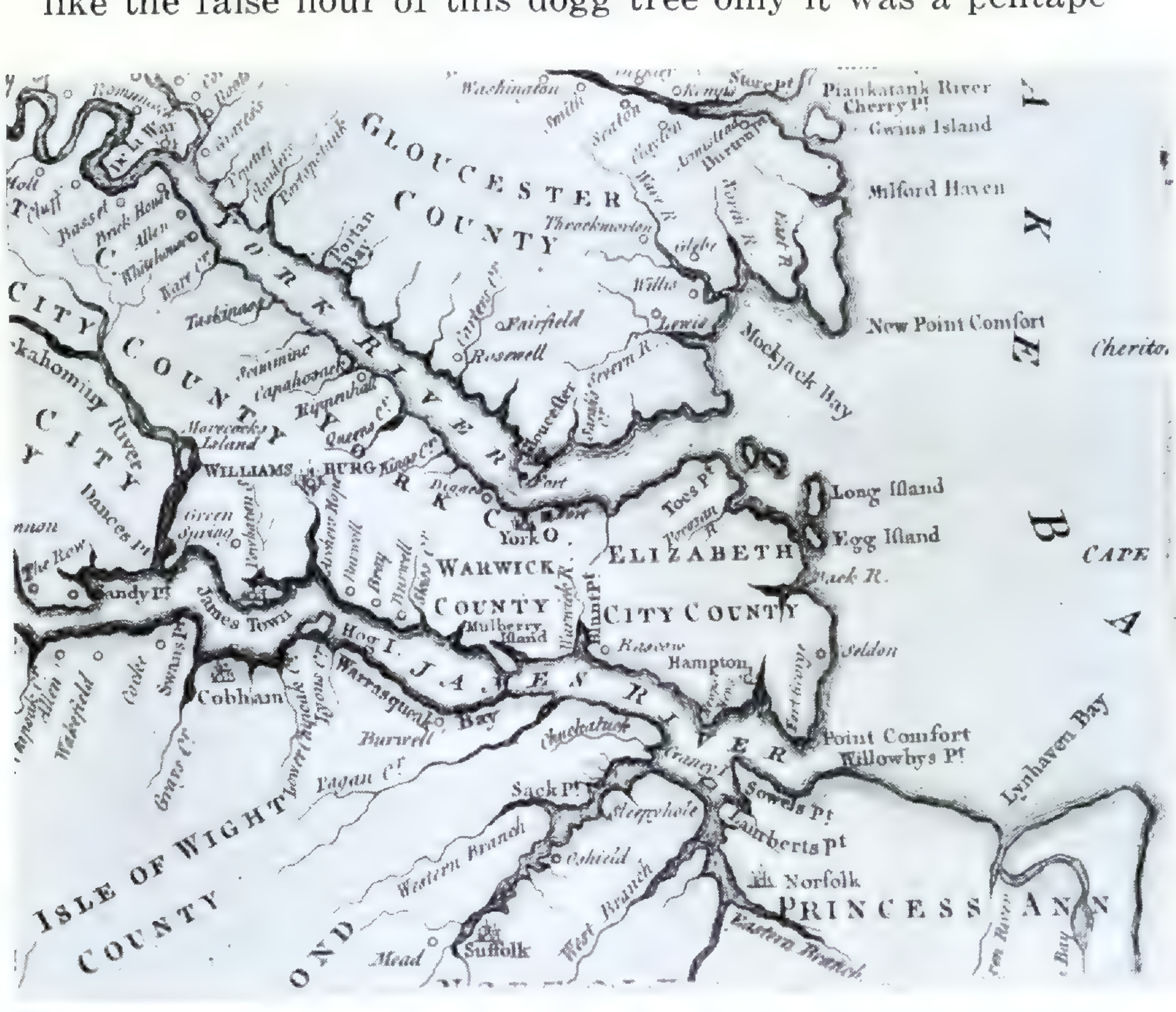

Figure 1. Portion of the 1751 Fry and Jefferson map of Virginia, taken from the facsimile, 2nd ed., Charlottesville, University Press of Virginia, 1966.

Figure 2. *Stewartia ovata* from the Archers Hope population as drawn by Frances Dayton, 1956.

talon, the Dogg tree flower being as I s'd a tetrapetalon, afterwards comeing that way, I went to see wt fruit it bear, they were not nere ripe, but were about the bignesse of a Walnut, & had 5 ridges ran down the fruit, winged, How bigg they might grow I know not"

The reverend gentleman was, of course, recording observations on the plant that exactly one hundred years later Cavanilles was to describe as *Malachodendron ovatum*. Compare Clayton's description with the drawings made by Frances Dayton of specimens taken in 1956 from the location visited by the rector in 1685: flowering, June 29; fruiting, July 29 (Figure 2). The letter quoted above was written fifty-four years before Linnaeus described *Stewartia*, sixty-one years before John Mitchell published *Malachodendron*, sixty-six years before Linnaeus (in *Species Plantarum*, 1753) made the combination *Stewartia Malachodendron* (type species), two hundred thirty-four years before Grimes collected specimens at approximately the same place (*Grimes 3818*, NY: in flower, June 24, 1921; on dry wooded slope along tributary of College Creek south of Williamsburg).

Clayton associated in his memory the plants that came to be named *Cornus florida* and *Stewartia ovata*. Interesting it is, therefore, that the country people in the environs of Williamsburg sometimes call *Stewartia* as they find it in the woods Summer Dogwood (so reported to me by J. B. Brouwers, former Landscape Superintendent of Colonial Williamsburg who transplatend specimens from the wild into town).

Though only two species of *Stewartia* occur in the United States — about six in Asia, the American representatives have a complex taxonomic history (Fernald, 1936) which, I suspect, needs further clarification. John Clayton (1686-1773), the botanist, sent dried specimens of *Stewartia* to Gronovius in Holland and at least one living plant to Marc Catesby in England. Clayton collected in areas where we now know only *S. ovata* and not *S. Malachodendron*, though in the years that have intervened since Clayton arrived in Virginia in 1705 many Coastal Plain populations of either or both species might have been completely destroyed. But we do know from the Archers Hope stand that *Stewartia* does have survival persistence even in an agricultural area. Fernald seemed to be under the impression that Clayton

sent back specimens only of *S. Malachodendron:* I question that. John Mitchell wrote a letter to Marc Cateby (*Natural History of Carolina*, etc.) with the important statement: "There are five styles, as I showed you in a specimen I have." Mitchell was at the time discussing his genus *Malachodendron,* whence Linnaeus took the specific epithet. Nowadays, *S. ovata* is considered to be unique in having five styles.

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PARASITISM IN XIMENIA (OLACACEAE)

R. DeFilipps

Ximenia is a small genus of tropical shrubs and trees in the dicotyledonous family Olacaceae. A trend of parasitism occurs in the order Santalales, which includes Olacaceae, Loranthaceae, Viscaceae, Santalaceae, and Misodendraceae, as circumscribed by Kuijt (1968). In the Olacaceae, which is thought to be the plexus from which all other Santalalean families take their origin, parasitism has been documented in three of the approximately twenty genera: *Ximenia*, *Olax*, and *Ptychopetalum*.

Root-hemiparasitism in the Olacaceae was first reported by Heckel (1900), who observed haustoria of *Ximenia americana* L. var. *americana* attached to *Piper chaba* Hunter. He planted *Ximenia* seeds collected near Libreville, Gabon, in individual pots containing *Tamarindus indica* L. (Leguminosae), *Erythroxylon coca* Lam. (Erythroxylaceae), *Hura crepitans* L. (Euphorbiaceae), *Ficus laurifolia* Hort. (Moraceae) and *Piper chaba* Hunter (as *Chavica officinarum* Mig., Piperaceae). Of these intended host species, only *Piper* was attacked after two years.

Barber (1907) observed haustoria of *Ximenia americana* var. *americana* in Madras, India, attached to roots of a dicotyledonous plant. Some haustoria attained the large size of one square inch in surface area. The haustorial and host tissues were illustrated, but the host species was not named.

The present study was made to confirm parasitism in *Ximenia*. In November, 1965, shrubs of *X. americana* var. *americana* were received from a natural habitat near Immokalee, Florida, and specimens of *Pelargonium hortorum* Bailey (Geraniaceae) were later placed in a pot with one of them. When harvested in June 1968, numerous haustoria were found attached to the host roots (Fig. 1). Several of the large *Ximenia* shrubs are now growing in the absence of host plants, which may indicate that these organisms are facultative, rather than obligative, parasites.

Fig. 1. Haustoria of *Ximenia americana* L. var. *americana* (pale) attacking roots of *Pelargonium hortorum* Bailey (dark) and concomitantly parasitizing itself (arrows), × 1.

Seeds of *Ximenia americana* var. *americana* were obtained from Immokalee in September 1966 and grown in individual pots. In May, 1967, these intended host species were selected arbitrarily and introduced into the pots: *Bryophyllum pinnatum* (Lam.) Oken (Crassulaceae), *Rhoeo spathacea* (Swartz) Stearn (Commelinaceae), *Zamia floridana* DC. (Cycadaceae). All of the host plants, harvested in October, 1967, and January, and June, 1968, had haustoria attached to their roots. This caused neither a visible lack of vigor in the hosts nor increase in vigor in the parasites.

Heckel (1899, 1900) noted that *Ximenia americana* var. *americana,* when growing in the absence of a host, will produce haustoria which attack its own roots, the subterranean portion of the stem, and the endosperm of the seed from which the plant grows. In the present study, the shrub which parasitized *Pelargonium* concomitantly produced haustoria which attached to its own roots (Fig. 1). A specimen of *X. caffra* Sonder var. *natalensis* Sonder, grown alone from seed obtained from Salisbury, Rhodesia, also formed a number of haustoria which parasitized its own roots. Other examples of this phenomenon in the Santalales are cited by Fineran (1965).

The attachment of *Ximenia* haustoria to non-living objects has not been previously reported; prior reports exist for *Olax* (Olacaceae) and genera in the Santalaceae, Loranthaceae and Scrophulariaceae. In this study, haustoria on roots of *X. americana* var. *americana* shrubs were observed attached to a small stone, a piece of charcoal, bits of plastic intentionally sown in potting soil, and to the cellophane-like coating on the interior of a metal can in which one specimen was growing (Fig. 2). Therefore, the presence of living host roots is not always necessary for the initiation of *Ximenia* haustoria. A similar conclusion was made by Piehl (1962) for *Melampyrum* and Fineran (1965) for *Exocarpus*.

The attachments to non-living objects are FAA-preserved in the Southern Illinois University Herbarium. Histological

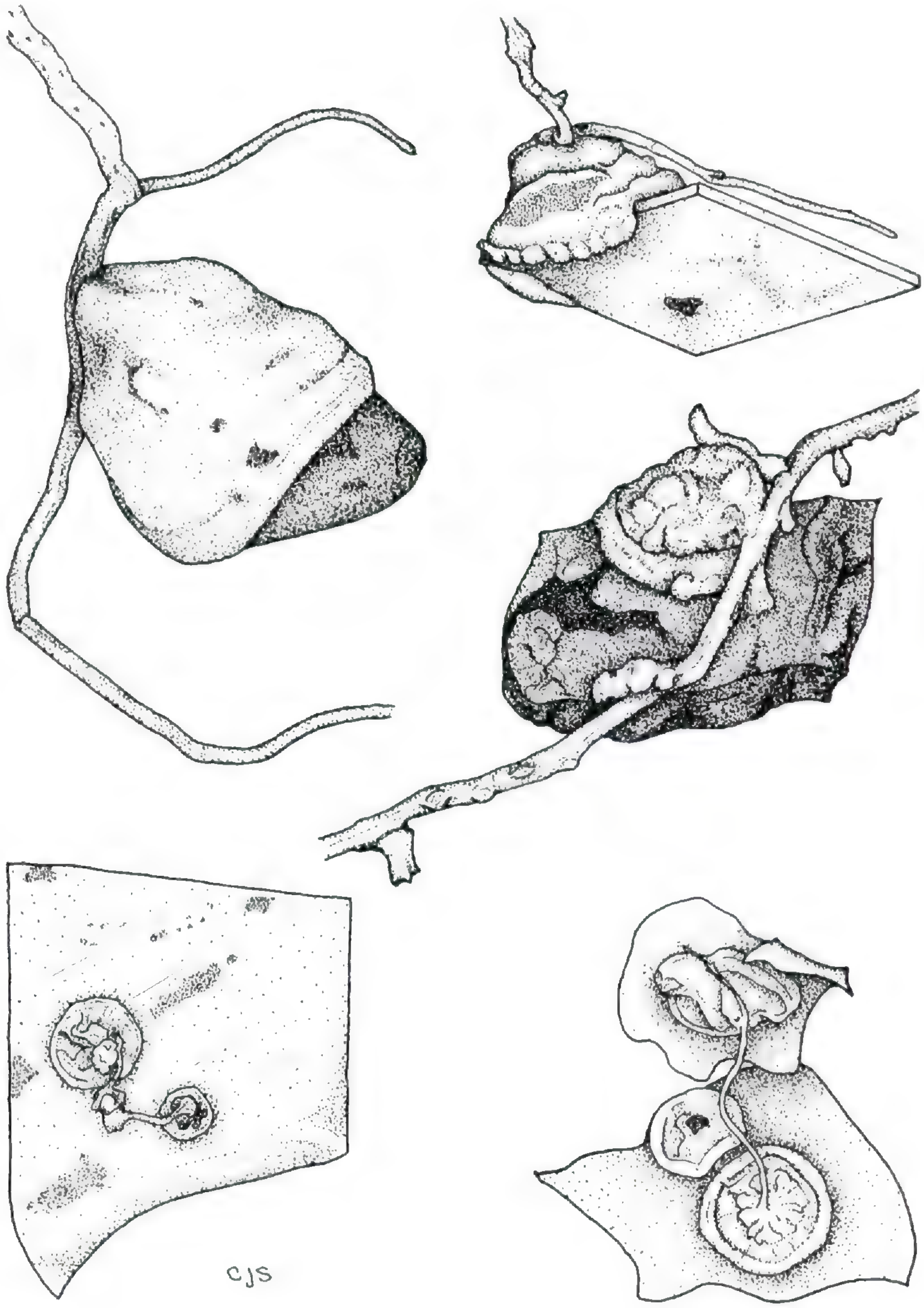

Fig. 2. Haustoria of *Ximenia americana* L. var. *americana* attached to non-living objects. Upper left: Stone, × 10. Lower left: Cellophane-like coating on metal, × 2. Upper right: Plastic, × 3.5. Center right: Charcoal, × 4. Lower right: Cellophane-like coating removed from metal, × 2.

studies of the parasite-host attachments and attachments between *Ximenia* roots on the same plant are in progress in the laboratory of Dr. B. Fineran, Botany Department, University of Canterbury, Christchurch, New Zealand.

Plants were grown in the Production Greenhouse, Southern Illinois University, Carbondale. Mr. R. Wadlow, of Immokalee, Florida, supplied seeds and shrubs of *Ximenia americana*. Mr. T. Miller and Dr. H. Wild, Chief Botanist, Federal Herbarium, Salisbury, Rhodesia supplied seeds of *X. caffra*. The figures are by Mr. C. Seliger.

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PHYTOPLANKTON FLORA OF NEWFOUND AND WINNISQUAM LAKES, NEW HAMPSHIRE

GERHARD K. GRUENDLING

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Few comprehensive seasonal studies have been made of New England phytoplankton species (particularly in large lakes), and most of these investigations have been restricted to Massachusetts (Auyang, 1962; Croasdale, 1935; Spencer, 1950; Stone, 1900; Wright, 1964) and Connecticut (Hutchinson, 1944; Hylander, 1928; Patrick, 1943; Riley, 1940). Investigations of the freshwater algal flora of New Hampshire have dealt primarily with its rich desmid populations (Cushman, 1930b, c, 1905a, b, c, 1906, 1907a, b, 1908a, b; Hastings, 1892; Whelden, 1942; Wood, 1869). The New Hampshire Fish and Game Department has conducted limited investigations of phytoplankton in conjunction with its biological surveys, but only generic designations were given (Edmundson, 1938; Edmundson and Fuller, 1937; Cole, 1939). As far as we are aware, only two other published accounts describe phytoplankton species from New Hampshire (Collins, 1909, 1912, 1918b; Gustafson, 1942).

The present systematic account of phytoplankton is a portion of a detailed investigation of the composition, periodicity, and abundance of phytoplankton species in relation to the trophic status of Newfound and Winnisquam Lakes, New Hampshire (Gruendling and Mathieson, in press). Newfound Lake is located in Grafton County (Figure 1), while Winnisquam Lake is in Belknap County (Figure 2). Both lakes are preglacial land forms which were slightly modified (mainly deepened) by Pleistocene glaciation (Billings, 1956). The lakes are similar in size, maximum depth, altitude, underlying geology, and certain chemical and physical characteristics. The chief difference between the two lakes is that Newfound Lake is oligotrophic, while Winnisquam Lake is receiving treated sewage

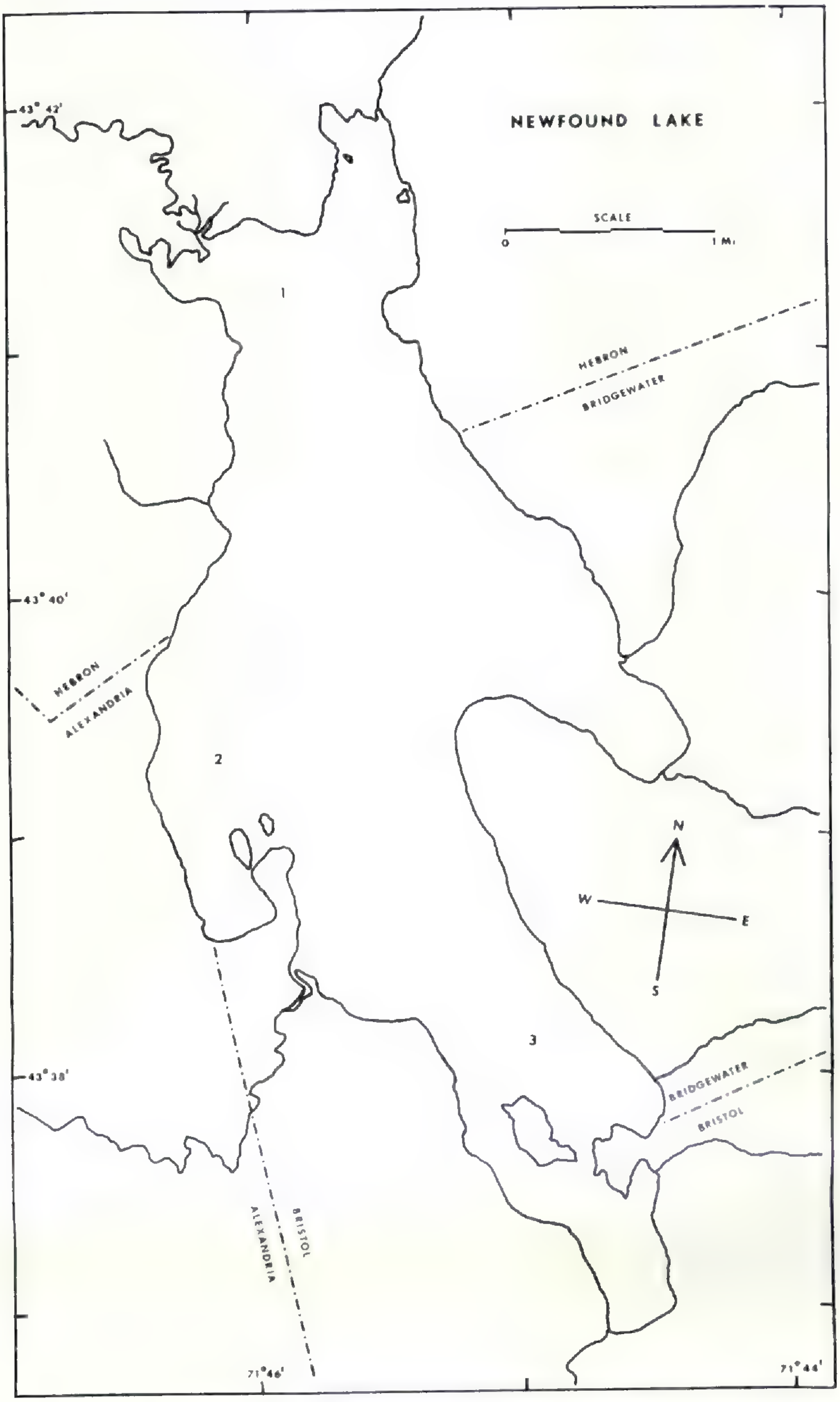

Fig. 1. Map of Newfound Lake.

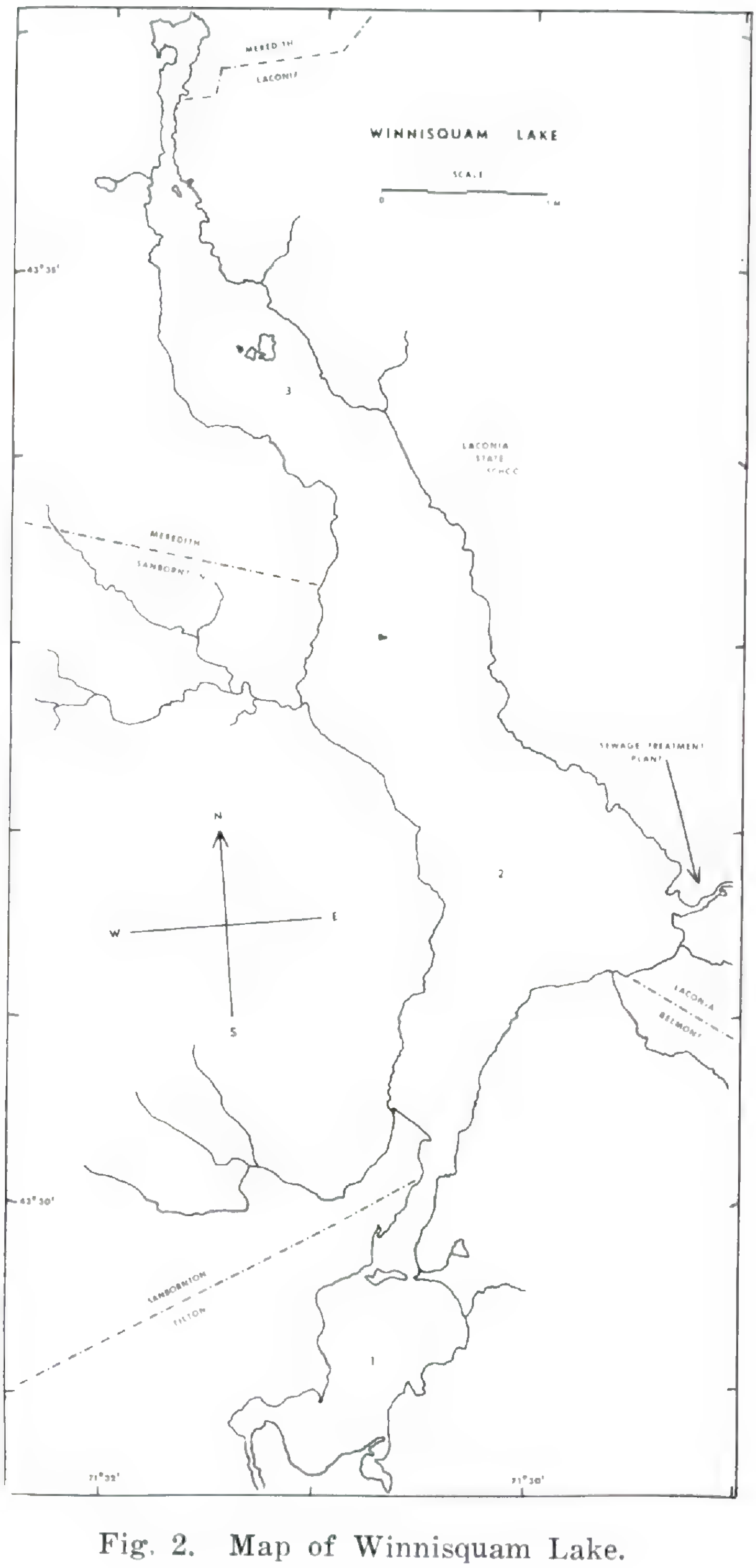

Fig. 2. Map of Winnisquam Lake.

effluent and is in the early stages of eutrophication. The following paper describes the floristic differences between the two lakes and gives specific information regarding the seasonal and vertical distribution of many phytoplankton species. New records for the state of New Hampshire and New England are also designated

Regular collections (approximately fortnightly) were made at Newfound and Winnisquam Lakes from June 25, 1966 to November 10, 1967. Three stations were occupied at each lake and samples were taken from various depths (1, 3, 5, 10, 15, and 20 meters) with a 4-liter Van Dorn water sampler as well as from vertical hauls (20 meters) with a #25 plankton net. Living samples, which were concentrated through a .45 μ millipore filter or a plankton net, were used whenever possible for the identification of organisms. Fixed samples (1% Acid Lugol's Solution) were only used occasionally for identification of species. The generic designations listed by Smith (1950) were used whenever possible. Specific identifications were determined from a variety of sources: Ahlstrom (1937); Eddy (1930); Huber-Pestalozzi (1938-1961); Patrick and Reimer (1966); Prescott (1962); Smith (1920, 1924); Teiling (1967); West and West (1904-1912); West, West and Carter (1923). Voucher specimens have been deposited in the University of New Hampshire Herbarium.

Synopsis of Species[1]

CYANOPHYCEAE

*__Anabaena circinalis__ Rabenhorst (Figure 7). Common at Winnisquam Lake during the summer; mixed with *Anabaena flos-aquae*, but not as abundant. Akinetes were present throughout the growing season (June to October).

*__Anabaena flos-aquae__ (Lyngbye) De Brébisson (Figure 10). A major constituent of water blooms at Winnisquam Lake in July and August, often occurring in large tufts.

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[1] *presumed to be a newly published record for New Hampshire.
**presumed to be a newly published record for New England.

Rarely found at Newfound Lake. Akinetes were present throughout the growing season (June to November).

****Anabaena scheremetievi** Elenkin (Figure 6). Found in small quantities at Winnisquam Lake from August to November. Akinetes were present in all collections.

Aphanizomenon flos-aquae (L.) Ralfs (Figure 11). Present throughout the year at Winnisquam Lake. The largest quantities were found during the summer and fall. Akinetes were only observed from September to November, 1967. During the winter and spring the trichomes were "rafted" while throughout the rest of the year they occurred as single trichomes. Cells were slightly smaller (3.9-5.0 μ in diameter) than those listed by Prescott (1962).

***Aphanothece clathrata** G. S. West. Abundant in the surface waters at Newfound Lake from June to November.

***Chroococcus limneticus** Lemmermann. Common at Newfound Lake from June to November.

***Chroococcus minimum** (Keissl.) Lemmermann. Rare; found at Newfound Lake from June to November.

***Gloeothece linearis** Naegeli. Common throughout the water column at Newfound Lake from June to November.

***Gloeotrichia echinulata** (J. E. Smith) Richter (Figure 5). Present near the surface of Winnisquam Lake from July to September. Akinetes were present throughout the

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Fig. 3. *Dinobryon cylindricum* Imhof with statospores, ×500.

Fig. 4. *Dinobryon bavaricum* Imhof with statospores, ×500.

Fig. 5. *Gloeotrichia echinulata* (J. E. Smith) P. Richter with akinetes, ×500.

Fig. 6. *Anabaena scheremetievi* Elenkin with akinete, ×500.

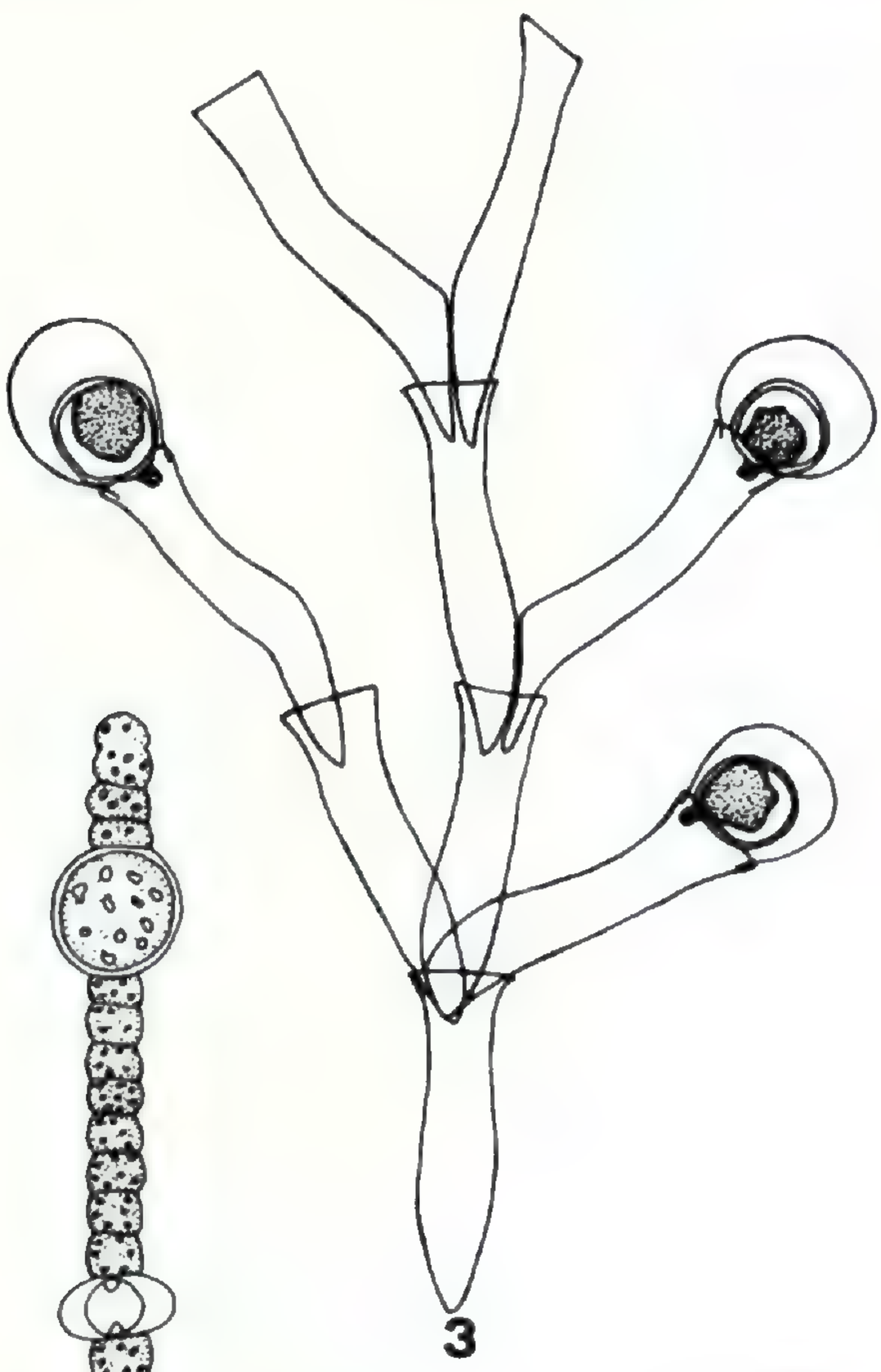
Fig. 7. *Anabaena circinalis* Rabenhorst with akinetes, ×500.

Fig. 8. *Melosira italica* var. *tenuissima* (Grun.) Mull. with auxospore, ×500.

Fig. 9. Germinating auxospore of *Melosira italica* var. *tenuissima*, ×500.

Fig. 10. *Anabaena flos-aquae* (Lyngbye) De Brébisson with akinetes, ×500.

Fig. 11. *Aphanizomenon flos-aquae* (L.) Ralfs with akinete, ×500.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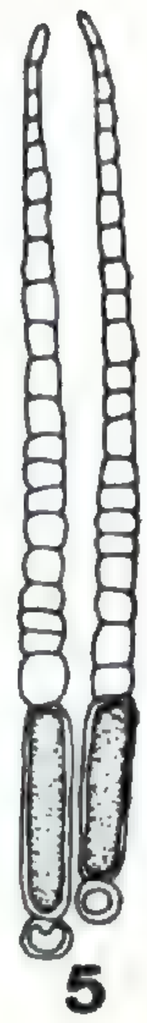
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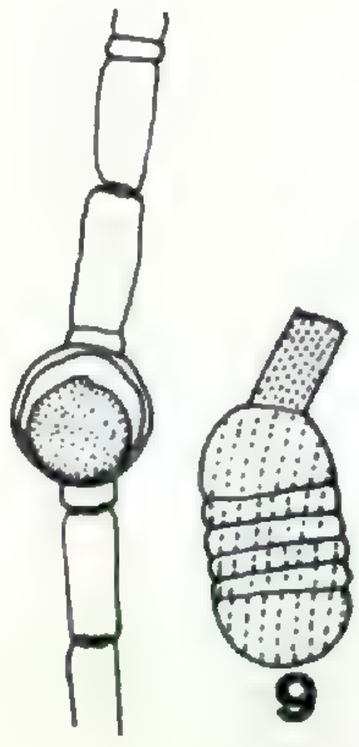
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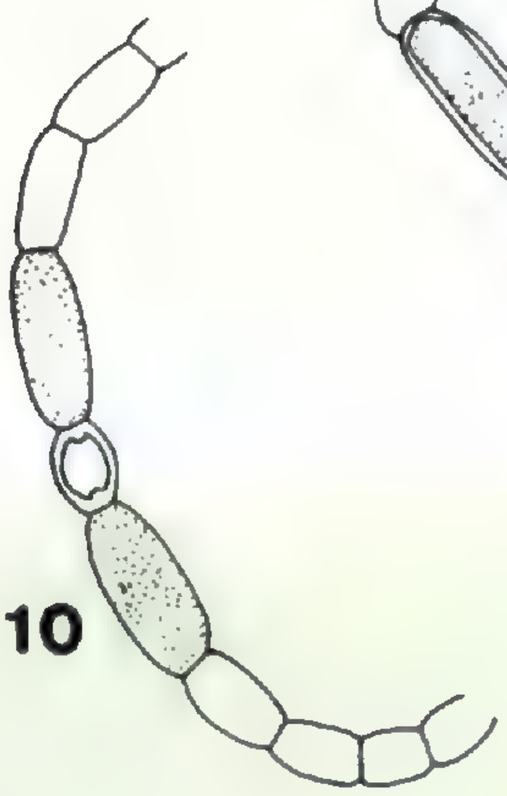
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growing season. Although it never formed water blooms, on occasion it was dense enough to be seen with the unaided eye.

****Gomphosphaeria aponina** var. **delicatula** Virieux. Present throughout the year at both lakes, but never in great abundance. **G. aponina** has been recorded from Massachusetts (Croasdale, 1935) and from Connecticut (Hylander, 1928), but the var. *delicatula* has not previously been recorded from New England.

Gomphosphaeria lacustris Chodat. A dominant organism throughout the year at Newfound Lake. Its maximum abundance was recorded during July and August.

****Gomphosphaeria lacustris** var. **compacta** Lemmermann. Found in small quantities throughout the year at Newfound Lake; only evident from August to November at Winnisquam Lake.

***Merismopedia punctata** Meyen. Common at Newfound Lake from June to November.

***Merismopedia tenuissima** Lemmermann. Abundant at Newfound Lake from June to November; a maximum peak was recorded in July.

***Oscillatoria granulata** Gardner. Most common in shallow areas of Winnisquam Lake after heavy rainfalls. Probably not a true planktonic species.

***Oscillatoria limnetica** Lemmermann. Found throughout the year at Winnisquam Lake; the dominant organism in April, May, and November and December. Its populations showed a marked seasonal difference vertically within the water column. During the winter, large quantities were present in the upper three meters but by the end of March the bulk of the population had settled to 10-15 meters — even though it was still increasing in numbers. During the remainder of the year it again sank to lower depths.

****Spirulina laxa** G. M. Smith. Found at Winnisquam Lake from July to September. Only evident at one location (10 to 15 meters); rare.

***Tolypothrix lanata** Wartmann. Found in small quantities

from July to November at Winnisquam Lake. Only collected in shallow portions of the lake, and probably not a true planktonic species. Akinetes were never observed.

CHLOROPHYCEAE

*__Ankistrodesmus falcatus__ (Corda) Ralfs. Relatively common at Winnisquam Lake from June to October but never reaching large numbers.

*__Ankistrodesmus falcatus__ var. __acicularis__ (A. Braun) G. S. West. Present at both lakes from June to October, but not as common as the typical plant.

*__Ankistrodesmus falcatus__ var. __mirabilis__ (W. and G. S. West) G. S. West. Very common throughout the year at Winnisquam Lake. One of the dominant organisms during the spring overturn (April and May).

*__Botryococcus braunii__ Kuetzing. Common throughout the year at both lakes; particularly during the winter at Newfound Lake. The color of the mucilage sheath varied from dark green to dark orange-brown.

**__Botryococcus protuberans__ var. __minor__ G. M. Smith (Figure 20). Present throughout the year at Newfound Lake, but not as abundant as *B. braunii*. Only found at Winnisquam Lake from February to early June.

*__Characium curvatum__ G. M. Smith. Found during the summer at Winnisquam Lake; growing epiphytically on fragments of *Oedogonium*.

*__Characium gracilipes__ Lambert. Found as an epiphyte on *Oedogonium* during August and September at Winnisquam Lake.

**__Characium limneticum__ Lemmermann (Figure 15). Found at Winnisquam Lake from July to September; rare.

**__Chlamydomonas dinobryonis__ G. M. Smith (Figure 12). Cells growing within the lorica of *Dinobryon cylindricum*. Observed a few times during June and July at Newfound Lake.

**__Chlorangium stentorinum__ (Ehrenberg) Stein. Found occasionally during July and August at Winnisquam Lake; growing attached to copepods.

****Closteriopsis longissima** Lemmermann (Figure 19). Found throughout the year at Winnisquam Lake but never in great abundance. It was always confined to deep water samples (15 meters and below) where light was barely detectable.

Closterium acerosum (Shrank) Ehrenberg. A few specimens were observed in September and November, 1966 at Winnisquam Lake; rare.

Closterium dianae Ehrenberg. Seen once in June at Winnisquam Lake.

Closterium kuetzingii De Brébisson. The most common species of *Closterium* found at both lakes; present throughout the year but never in any great quantity.

Closterium moniliferum (Bory) Ehrenberg. Seen once in November at Winnisquam Lake.

***Coelastrum microporum** Naegeli. Common from June to November at Winnisquam Lake. Only sporadically present throughout the summer at Newfound Lake.

***Cosmarium bioculatum** De Brébisson. Common throughout the year at Newfound Lake. It was usually found at depths below 10 meters.

Cosmarium contractum var. **papillatum** W. and G. S. West. The most abundant species of **Cosmarium** found at both lakes. It was most common at Newfound Lake, where it occurred throughout the year. At Winnisquam Lake it was only recorded from June to November.

Fig. 12. *Chlamydomonas dinobryonis* G. M. Smith, ×500.
Fig. 13. *Uroglenopsis americana* (Calkins) Lemmermann, ×500.
Fig. 14. *Schroederia judayii* G. M. Smith, ×750.
Fig. 15. *Characium limneticum* Lemmermann, ×500.
Fig. 16. *Colacium arbuscula* Stein, ×500.
Fig. 17. *Colacium vesiculosum* Ehrenberg, ×500.
Fig. 18. *Elakatothrix viridis* (Snow) Printz, ×500.
Fig. 19. *Closteriopsis longissima* Lemmermann, ×500.
Fig. 20. *Botryococcus protuberans* var. *minor* G. M. Smith, ×500.
Fig. 21. *Kirchneriella contorta* (Schmidle) Bohlin, ×750.
Fig. 22. *Nephrocytium limneticum* (G. M. Smith) G. M. Smith ×500.
Fig. 23. *Nephrocytium lunatum* W. West, ×500.

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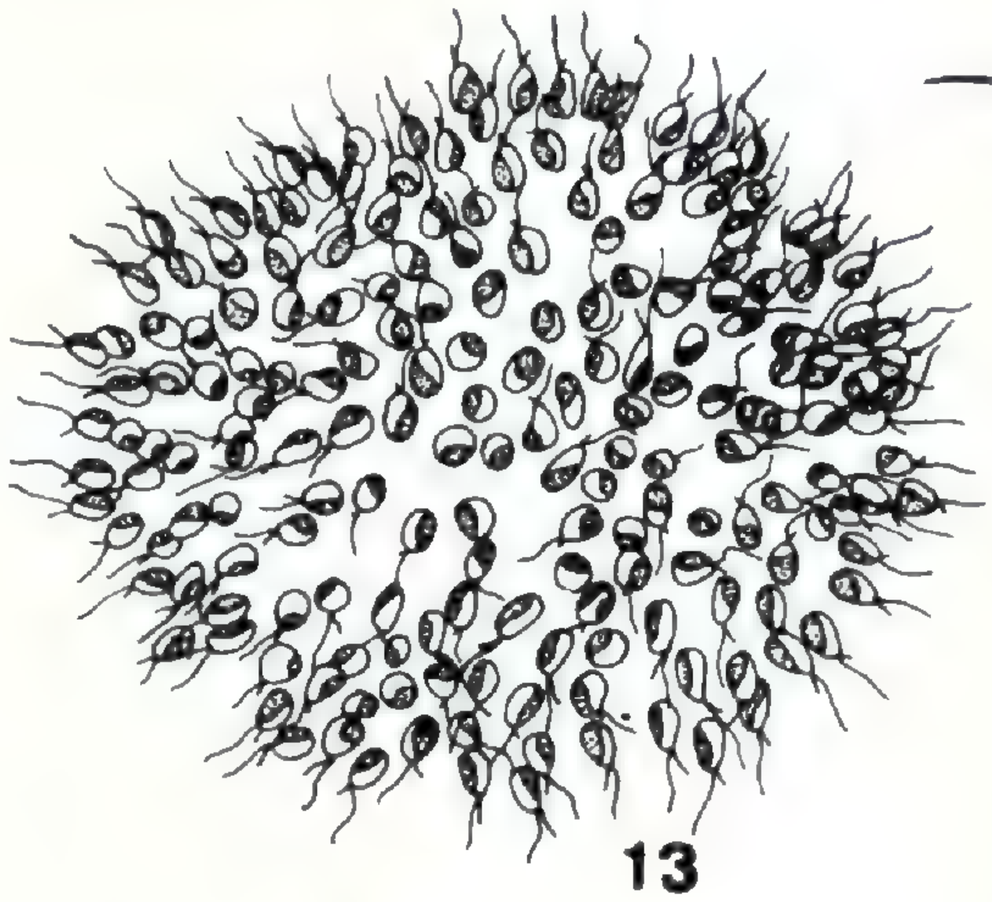

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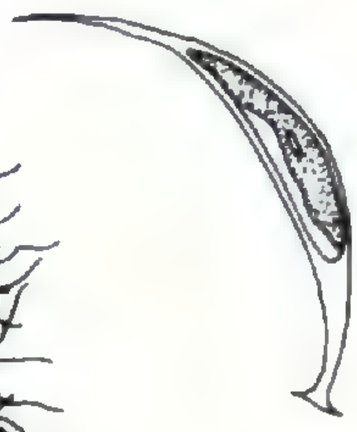

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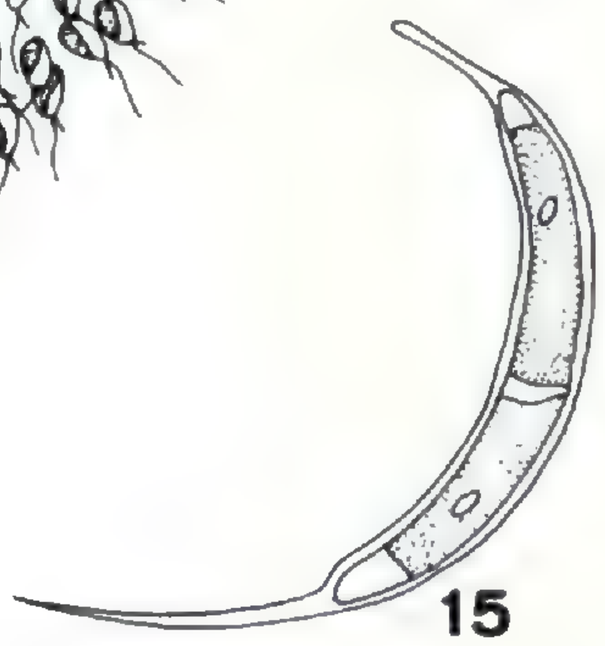

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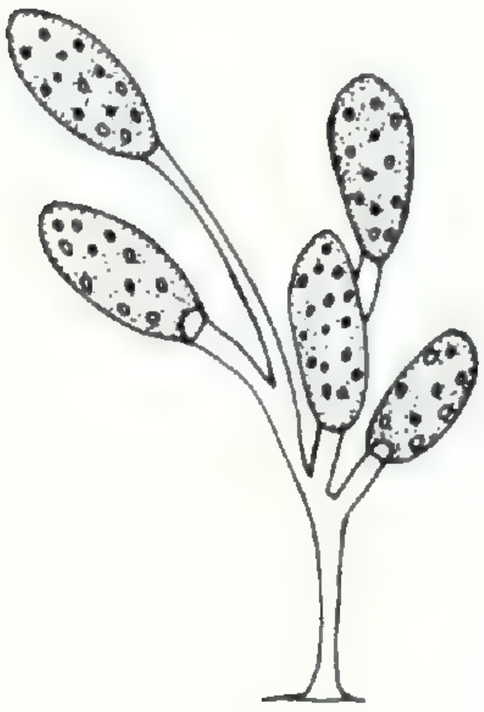

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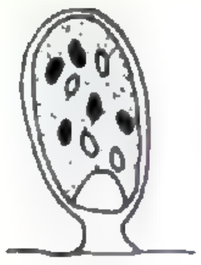

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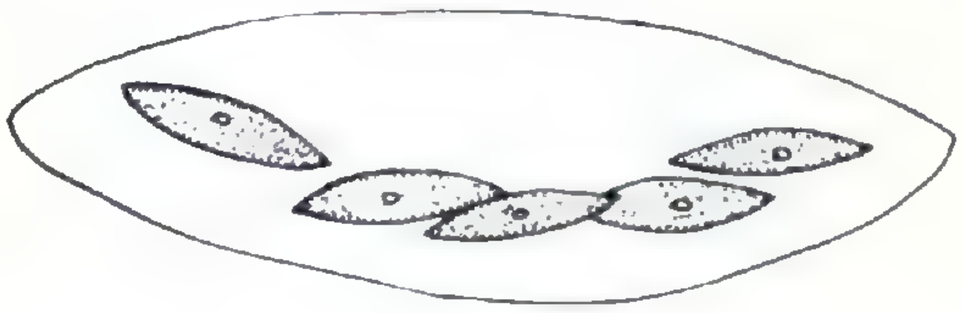

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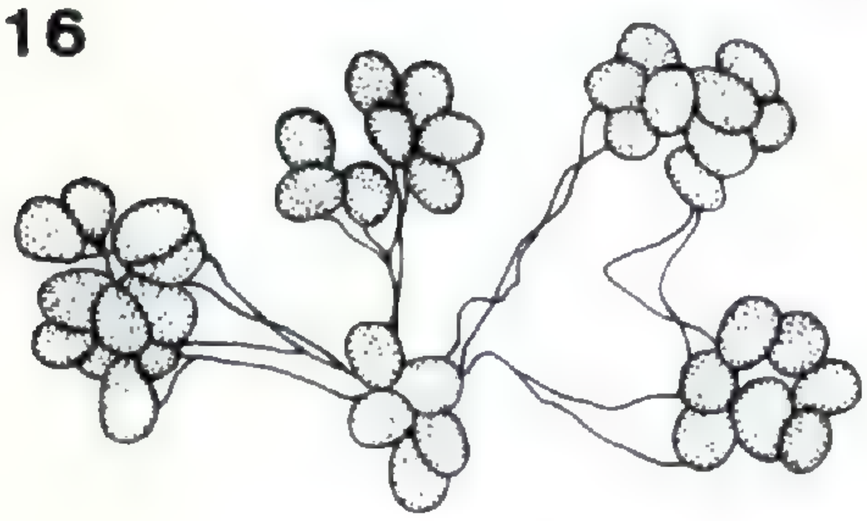

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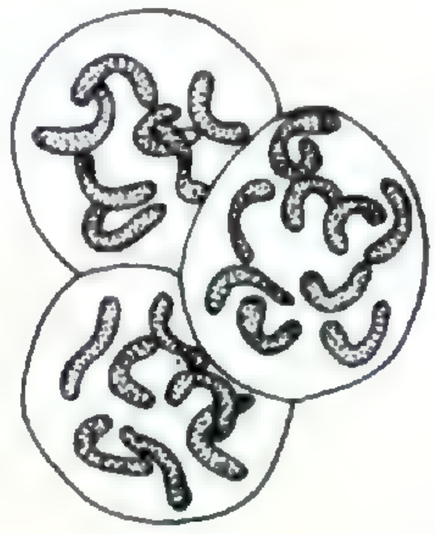

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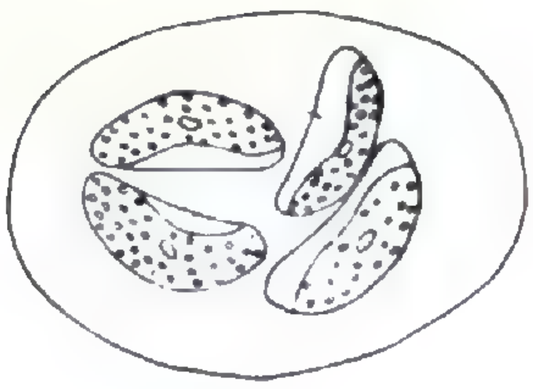

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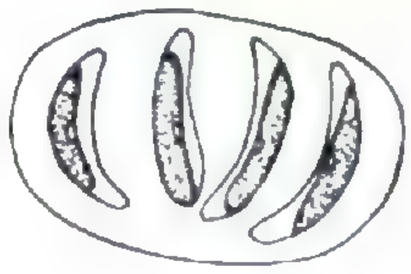

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*__Cosmarium punctulatum__ De Brébisson. Common from July to November at both lakes.

*__Crucigenia rectangularis__ (A. Braun) Gay. One of the dominant Chlorophyceae found at Newfound Lake; evident in all collections except in April and May. Its population size was relatively stable throughout the growing season. The alga was only observed a few times from July to November at Winnisquam Lake.

__Desmidium baileyi__ (Ralfs) Nordstedt. Found from July to October at Winnisquam Lake. Present as very long chains; uncommon.

__Desmidium swartzii__ C. A. Agardh. Sporadically present throughout the summer and early fall at both lakes.

*__Dictyosphaerium ehrenbergianum__ Naegeli. Occurring in small quantities from September to November at Winnisquam Lake; uncommon.

*__Dictyosphaerium pulchellum__ Wood. Very abundant throughout the year at Winnisquam Lake. It was the dominant Chlorophyceae during the summer and early fall. Less common at Newfound Lake, but still occurring throughout the year.

*__Dimorphococcus lunatus__ A. Braun. Common from September to November at Winnisquam Lake.

*__Elaktothrix gelatinosa__ Wille. Common from June to November at Winnisquam Lake.

**__Elaktothrix viridis__ (Snow) Printz (Figure 18). Present in very small quantities throughout most of the year (except April and May) at both lakes.

__Euastrum didelta__ (Turpin) Ralfs. Only a few specimens of this species were found during October and November, 1967 at Newfound Lake.

*__Euastrum pulchellum__ De Brébisson. Common from June to November at Newfound Lake.

*__Eudorina elegans__ Ehrenberg. Very abundant throughout the year at Winnisquam Lake; reaching peak numbers during July and August.

*__Gloeocystis ampla__ (Kuetzing) Lagerheim. Found occasionally from July to October at Winnisquam Lake.

*__Gloeocystis gigas__ (Kuetzing) Lagerheim. Common at both lakes from June to November. However, it was most abundant at Newfound Lake where it was a dominant member of the Chlorophyceae population during the summer and fall.

__Gloeocystis vesiculosa__ Naegeli. One of the dominant green algae present at Winnisquam Lake from June to November. Its maximum development occurred during July and August.

__Gonatozygon aculeatum__ Hastings. Abundant on two occasions (August and September, 1966) in the shallow portions of Winnisquam Lake.

__Gonatozygon monotaenium__ De Bary. Found once at Newfound Lake during August and September; rare.

*__Gonatozygon pilosum__ Wolle. Abundant during August and September, 1966 at Newfound Lake; never seen again after September, 1966.

__Gymnozyga moniliformis__ Ehrenberg. Observed once in September, 1967 at Newfound Lake.

__Hyalotheca dissiliens__ (J. E. Smith) De Brébisson. Found sporadically throughout the summer and fall at both lakes.

**__Kirchneriella contorta__ (Schmidle) Bohlin (Figure 21). A few specimens were found in two collections made in November, 1967 at Winnisquam Lake; rare.

*__Kirchneriella lunaris__ (Kirchner) Moebius. The commonest species of __Kirchneriella__ found at Winnisquam Lake; recorded from July to November.

*__Kirchneriella lunaris__ var. __dianae__ Bohlin. Found several times during August at Winnisquam Lake; mixed with the typical plant.

**__Kirchneriella obesa__ var. __aperta__ (Teil.) Brunnthaler. Uncommon, but found in most collections throughout the year at Winnisquam Lake. Only the typical plant has been recorded in New England — i.e. from Connecticut (Conn and Webster, 1908; Hylander, 1928) and Massachusetts (Croasdale, 1935).

Micrasterias radiata Hassall. One specimen was seen in September, 1966 at Winnisquam Lake.

Micrasterias radiosa (Lyngbye) Agardh. Observed once at Winnisquam Lake in August, 1967.

Mougeotia sp. Vegetative material was found in the plankton during the spring and summer at Winnisquam Lake.

****Nephrocytium ecdysiscepanum** W. West. A few specimens were observed during July and August at Winnisquam Lake.

****Nephrocytium limneticum** (G. M. Smith) G. M. Smith (Figure 22). Very common at Winnisquam Lake from June to November. Only a few specimens were found at Newfound Lake during August to October.

****Nephrocytium lunatum** W. West (Figure 23). Common from July to October at Winnisquam Lake.

Oedogonium spp. A number of different vegetative filaments were observed in the plankton from May to October at Winnisquam Lake. It was often heavily epiphytized.

***Oocystis borgei** Snow. The most common species of *Oocytis* found at both lakes. It was evident throughout the year, but it was never in any great abundance.

***Oocystis elliptica** W. West. Only a few specimens were found during August and September, 1966 at Winnisquam Lake; rare.

***Oocystis lacustris** Chodat. A few specimens were found during October and November, 1966 at Winnisquam Lake; rare.

***Oocystis parva** W. and G. S. West. A common species of *Oocystis* at Winnisquam Lake from July to September.

***Pediastrum araneosum** (Raciborski) G. M. Smith. Found only twice in September at Winnisquam Lake; rare.

***Pediastrum boryanum** var. **longicorne** Raciborski. Found once at Newfound Lake during October, 1966. The var. *longicorne* is differentiated from the typical species because of its swollen apical lobes.

***Pediastrum duplex** Meyen. The most common species of *Pediastrum* found at Winnisquam Lake. Evident

throughout the year, but never in very large numbers.

*__Pediastrum duplex__ var. __clathratum__ (A. Braun) Lagerheim. Common throughout the year at Winnisquam Lake.

*__Pediastrum duplex__ f. __gracilimum__ W. and G. S. West. Common at Winnisquam Lake from July to November. According to Prescott (1962) it is a growth form of the typical plant.

*__Pediastrum simplex__ var. __duodenarium__ (Bailey) Rabenhorst. Found once in June, 1967 at Newfound Lake.

*__Pediastrum tetras__ (Ehrenberg) Ralfs. A few specimens were found in July and August at Winnisquam Lake; uncommon.

*__Pediastrum tetras__ var. __tetraedon__ (Corda) Rabenhorst. More abundant at Winnisquam Lake than the typical plant; present from July to November.

__Pleurotaenium trabecula__ (Ehrenberg) Naegeli. Present sporadically throughout the summer and fall at Winnisquam Lake.

*__Quadrigula closterioides__ (Bohlin) Printz. Common throughout the year at Newfound Lake. Less common at Winnisquam Lake, and only occurring from June to November.

*__Quadrigula lacustris__ (Chodat) G. M. Smith. Common at Winnisquam Lake from July to October.

*__Scenedesmus abundans__ (Kirchner) Chodat. Only found a few times during July and August at Winnisquam Lake; rare.

*__Scenedesmus acutiformis__ Schroeder. Observed at Winnisquam Lake from June to November.

*__Scenedesmus arcuatus__ var. __platydisca__ G. M. Smith. Common from June to November at Winnisquam Lake.

*__Scenedesmus bijuga__ (Turp.) Lagerheim. Found occasionally during July and August at Winnisquam Lake.

*__Scenedesmus brasiliensis__ Bohlin. Common at Winnisquam Lake from June to November.

*__Scenedesmus dimorphus__ (Turp.) Kuetzing. Common at Winninsquam Lake from June to November.

*__Scenedesmus opoliensis__ P. Richter. Observed once in

October and once in November, 1967 at Winnisquam Lake.

Scenedesmus quadricauda (Turp.) De Brébisson. The dominant species of *Scenedesmus* in Winnisquam Lake; present throughout the year.

*__Scenedesmus quadricauda__ var. **parvus** G. M. Smith. Only found a few times during August and September at Winnisquam Lake.

*__Scenedesmus quadricauda__ var. **westii** G. M. Smith. Found a few times from August to October at Winnisquam Lake.

*__Scenedesmus serratus__ (Corda) Bohlin. The only species of *Scenedesmus* found at Newfound Lake. It was found from June to November, but never in any great abundance.

**__Schroederia judayi__ G. M. Smith (Figure 14). Very abundant from April to November at Winnisquam Lake. Maximum populations were evident in the spring and early fall, and generally in the upper five meters of the water column. The cells were either straight or arcuate.

*__Schroederia setigera__ (Schroeder) Lemmermann. Present throughout the year at Winnisquam Lake, but not as abundant as *S. judayi*.

*__Sorastrum spinulosum__ Naegeli. Only found a few times from August to October at Winnisquam Lake; rare.

*__Sphaerocystis schroeteri__ Chodat. Very common from April to October at Winnisquam Lake. Sparse at Newfound Lake, and only occurring in July and August. The

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Fig. 24. *Staurastrum pentacerum* (Wolle) G. M. Smith (top view) ×500.

Fig. 25. *Staurastrum pentacerum* (end view), ×500.

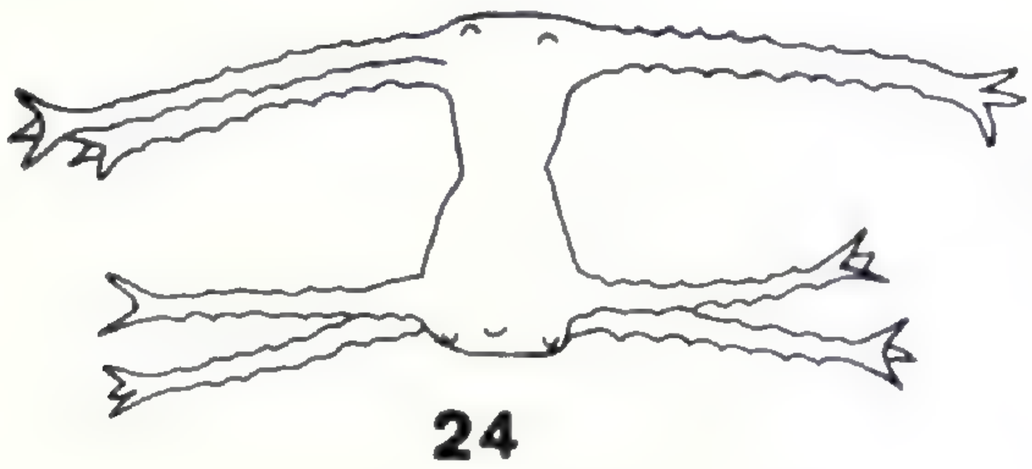
Fig. 26. *Staurastrum limneticum* var. *cornutum* G. M. Smith (top view), ×500.

Fig. 27. *Staurastrum limneticum* var. *cornutum* (end view), ×500.

Fig. 28. *Staurastrum pseudopelagicum* W. & G. S. West (top view), ×500.

Fig. 29. *Staurastrum manfeldtii* Delp. (Top view), ×500.

Fig. 30. *Staurastrum pingue* Teiling (top view), ×500.



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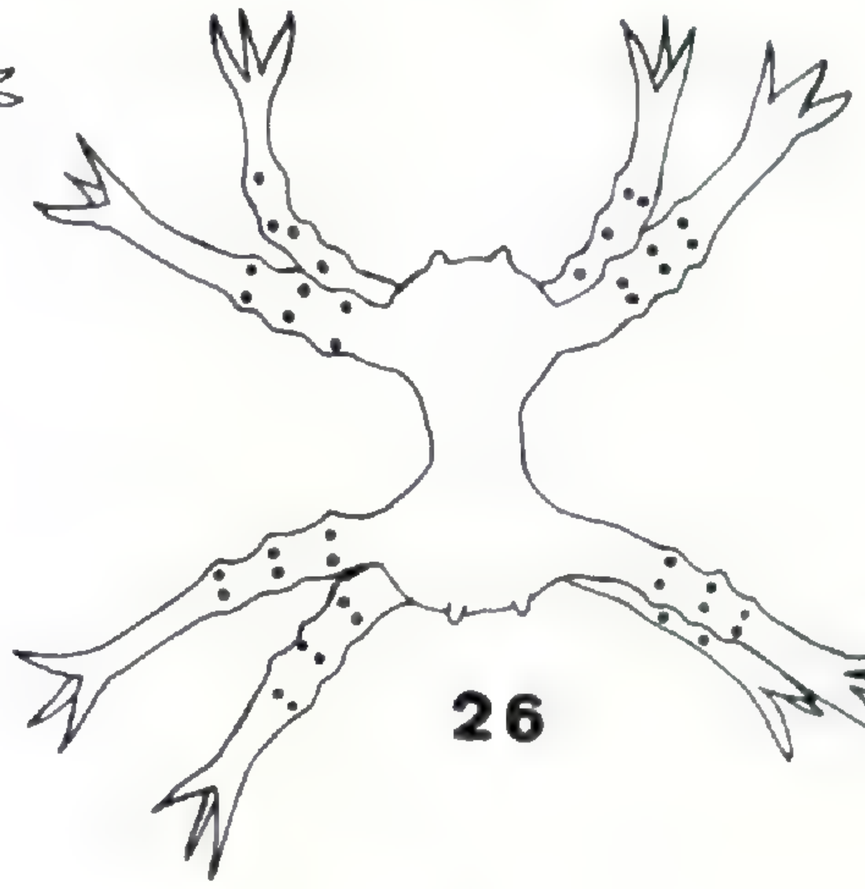

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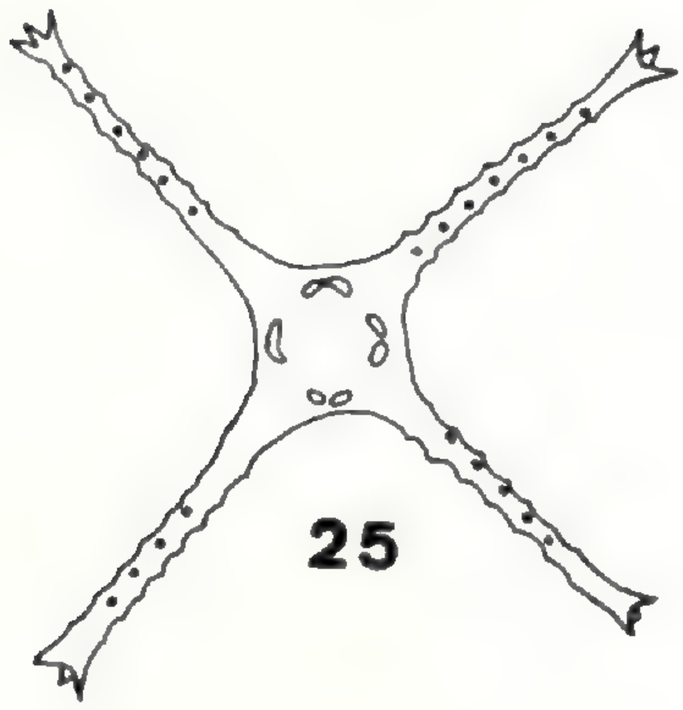

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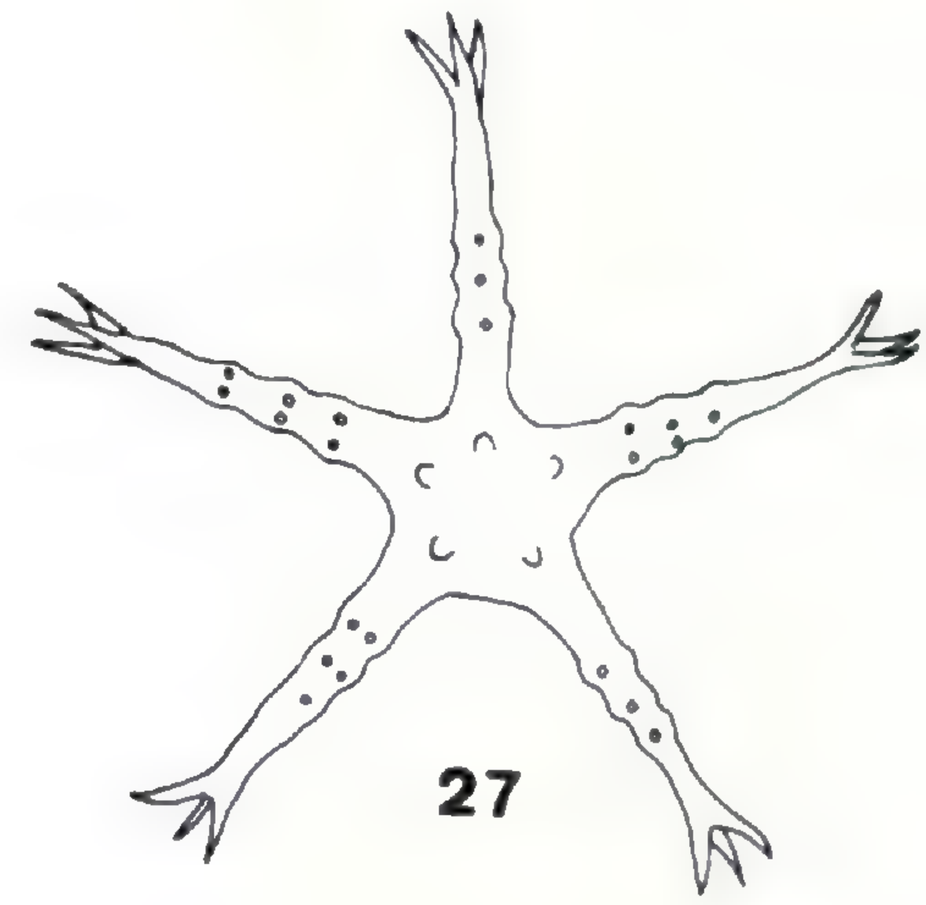

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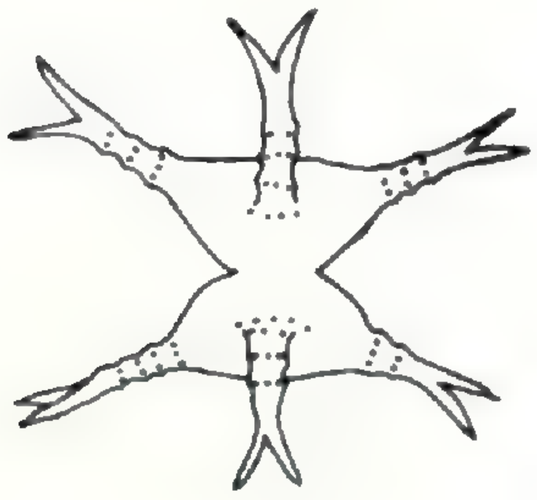

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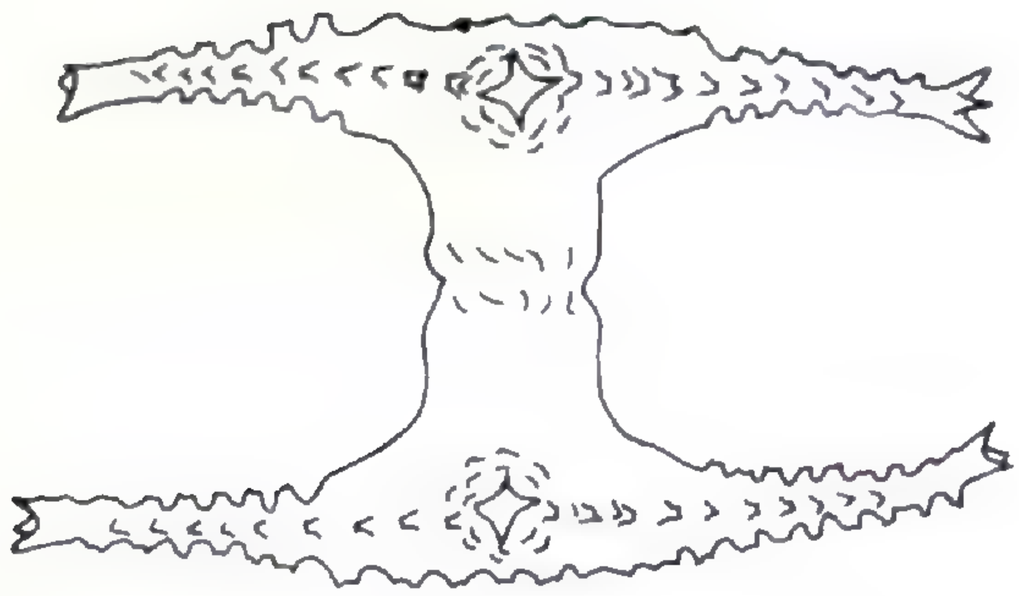

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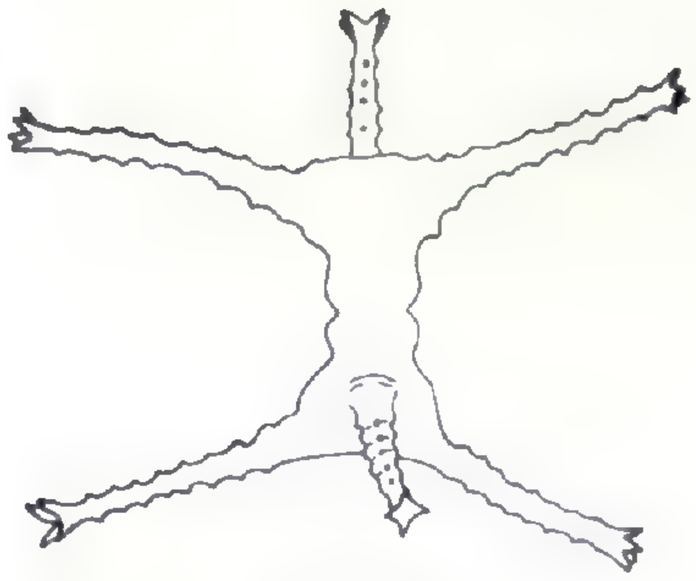

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plant was typically found as a many celled colony, but occasionally as a single cell.

Spirogyra spp. A number of different vegetative filaments (i.e., some with single and others with double chloroplasts) were found in the plankton at Winnisquam Lake from April to November.

*__Spondylosium planum__ (Wolle) W. and G. S. West. A common desmid from June to November at Winnisquam Lake. Only found occasionally in the fall at Newfound Lake.

Staurastrum anatinum var. **longibrachiatum** W. and G. S. West. A few specimens were found in each collection made throughout the year at Winnisquam Lake. The typical plant was previously recorded from Massachusetts (Cushman, 1930a; Stone, 1900), Maine (West, 1888), and New Hampshire (Collins, in PHYC. BOR-AM. XL, #1984).

*__Staurastrum ankyroides__ Wolle. Found once in Newfound Lake in September, 1966.

Staurastrum arctiscon (Ehrenberg) Lund. Found once from each lake; rare.

**__Staurastrum cingulum__ (W. and G. S. West) G. M. Smith. Present sporadically throughout the year at Winnisquam Lake.

Staurastrum johnsonii W. and G. S. West. Common throughout the year, except April and May, at Winnisquam Lake. Typically the plant is biradiate, but one specimen was found in which one semicell was triradiate and the other biradiate.

**__Staurastrum limneticum__ var. __cornutum__ G. M. Smith (Figures 26 & 27). Common at both lakes from August to November. Found with 4, 5, and 6 processes.

**__Staurastrum manfeldtii__ Delp. (Figure 29). Abundant from August to November, 1966 at Winnisquam Lake. Not seen during 1967.

**__Staurastrum pentacerum__ (Wolle) G. M. Smith (Figures 24 and 25). The most common species of *Staurastrum* found at Newfound Lake. Abundant throughout the year.

The number of processes ranged from 3-5; the "janus" forms with 3+4 or 3+5 were the most common.

*__Staurastrum pilosum__ Archer. Present at Winnisquam Lake in small numbers during October and November, 1966, but abundant from June to October, 1967.

**__Staurastrum pingue__ Teiling (Figure 30). The dominant desmid at Winnisquam Lake; maximum populations occurred during October and November. It was generally most abundant at approximately 10 meters.

*__Staurastrum pseudopelagicum__ W. and G. S. West (Figure 28). Common at Winnisquam Lake from June to November.

*__Staurastrum vestitum__ Ralfs. Found a few times in August and September at Winnisquam Lake; rare.

**__Staurodesmus bulnheimii__ (Raciborski) Brook (Equals *Arthrodesmus bulnheimii* in Smith, 1924). Found once in September, 1967 at Newfound Lake.

__Staurodesmus cuspidatus__ (De Brébisson) Teiling. (Equals *Staurastrum cuspidatum* in Smith, 1924). The most abundant species of Staurodesmus found at Newfound Lake; present throughout the year.

*__Staurodesmus dickiei__ (Ralfs) Lillieroth. (Equals *Staurastrum dickiei* in Iréné-Marie, 1939). Only found a few times during May and June at Winnisquam Lake.

*__Staurodesmus extensus__ var. __joshuae__ (Gutwinski) Teiling. (Equals *Arthrodesmus incus* var. *extensus* in Smith, 1924). Present sporadically throughout the year at both lakes. However, it was more abundant at Newfound Lake.

*__Staurodesmus incus__ var. __ralfsii__ (W. West) Teiling. (Equals *Arthrodesmus ralfsii* in Smith, 1924). Common from February to July at both lakes, but most abundant when the water temperatures are low.

*__Staurodesmus mamillatus__ var. __maximum__ (W. West) Teiling. (Equals *Staurastrum cuspidatum* var. *canadense* in Smith, 1924). Very common throughout the year at Newfound Lake; less abundant at Winnisquam Lake and only occurring from July to November.

Staurodesmus megacanthus (Lund) Thunmark. (Equals *Staurastrum megacanthum* in Smith, 1924). Very common throughout the year at Newfound Lake; less abundant at Winnisquam Lake and only occurring from April to November.

***Staurodesmus subtriangularis** (Borge) Teiling. (Equals *Arthrodesmus triangularis* var. *subtriangularis* in Smith 1924). Present sporadically throughout the year at both lakes.

***Stylosphaeridium stipitatum** (Bachmann) Geitler and Gimesi. Found commonly as an epiphyte on *Gomphosphaeria* at Newfound Lake; collected from July to October.

***Tetraedron limneticum** Borge. Observed once in August, 1967 at Newfound Lake.

***Ulothrix subconstricta** G. S. West. Very common from June to November at Winnisquam Lake.

***Ulothrix tenerrima** Kuetzing. Common from April to May at Winnisquam Lake.

***Ulothrix variabilis** Kuetzing. Found occasionally from June to August at Winnisquam Lake.

Xanthidium antilopaeum (De Brébisson) Kuetzing. Found a number of times during September to November at Winnisquam Lake.

Xanthidium antilopaeum var. **polymazum** Nordstedt. Found once in October, 1966 at Newfound Lake.

EUGLENOPHYCEAE

****Colacium arbuscula** Stein (Figure 16). Found attached to various zooplankton. Most common at Newfound Lake, where it was seen every month except February and March. It was seen from June to August at Winnisquam Lake.

****Colacium vesiculosum** Ehrenberg (Figure 17). Found throughout the year at both lakes. Epizooic on various Cladocera; more common than *C. arbuscula.*

***Euglena spirogyra** Ehrenberg. Found once (April) in

shallow water at Winnisquam Lake — after a rainfall. Probably not a true planktonic species.

XANTHOPHYCEAE

****Gloeobotrys limneticus** (G. M. Smith) Pascher (Figure 42). Common at Newfound Lake from August to November. Usually evident below ten meters. Less abundant at Winnisquam Lake where it was found from July to October.

***Ophiocytium capitatum** Wolle. Found only rarely at Newfound Lake from September to November.

***Stipitococcus capense** Prescott. Found at a shallow station at Winnisquam Lake. Epiphytic on various filamentous algae, especially *Oedogonium,* and once on the lorica of *Dinobryon divergens.* Found from July to September; rare.

CHRYSOPHYCEAE

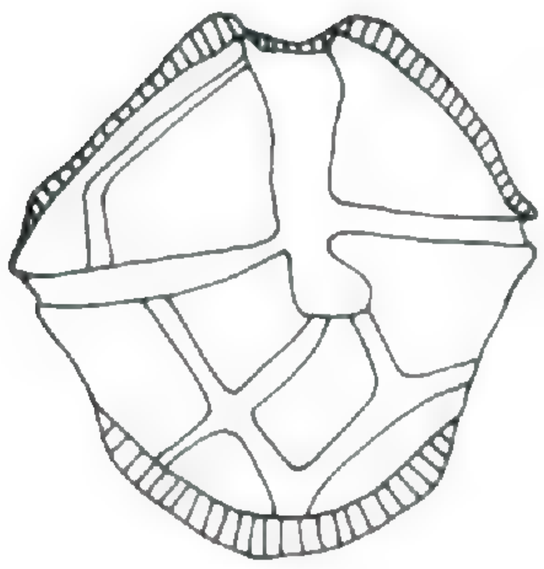
***Chrysosphaerella longispina** Lauterborn. Common at Newfound Lake from July to November; reaching maximum numbers in July and August. Generally evident below 10 meters. Rarely found at Winnisquam Lake (September to November).

****Diceras phaseolus** Fott. Found sporadically throughout the summer at Newfound Lake; rare.

***Dinobryon bavaricum** Imhof (Figure 4). Very common throughout the year at both lakes. Maximum populations were evident in June and July at Newfound Lake. Statospores were also evident at the same time. The maximum quantities were usually found at 10 meters. The size of the lorica in the upper portion of the colony was usually longer (90-100μ) than that in the lower portion (65-75μ).

****Dinobryon crenulatum** W. and G. S. West (Figures 35 & 36). Found sporadically throughout the year at Newfound Lake; rare.

***Dinobryon cylindricum** Imhof (Figure 3). Common throughout the year at both lakes. At Newfound Lake the maximum numbers were found during June, July



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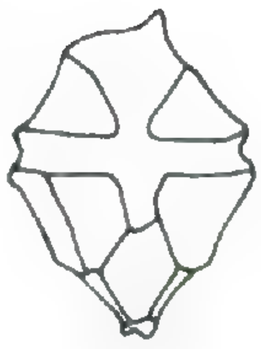

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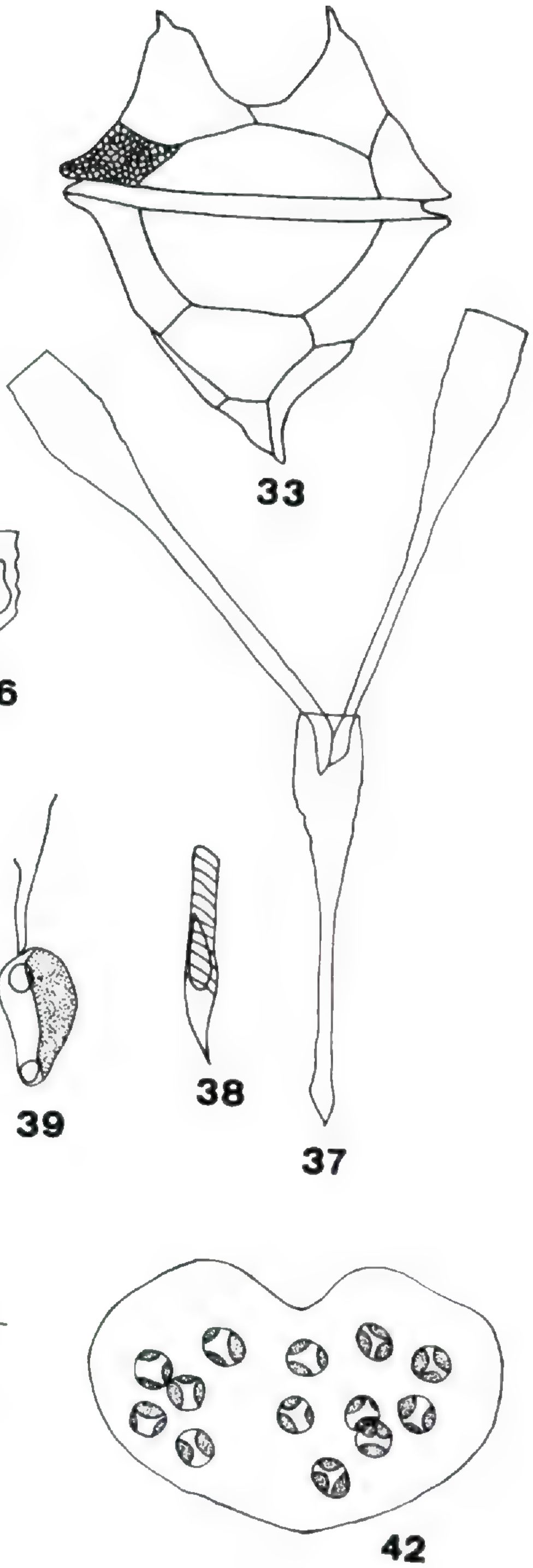

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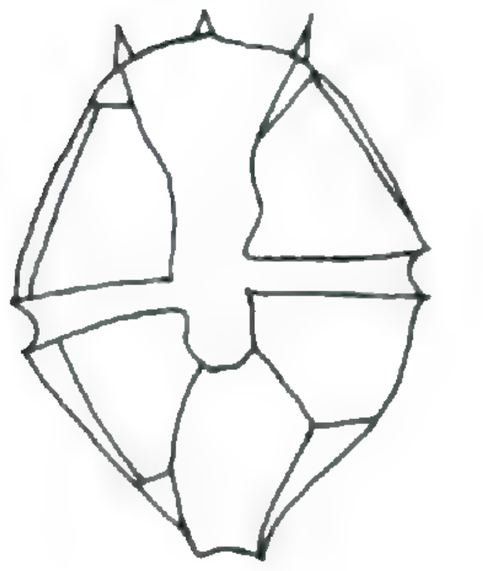

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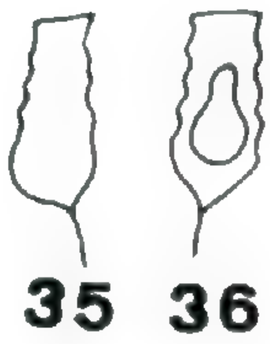

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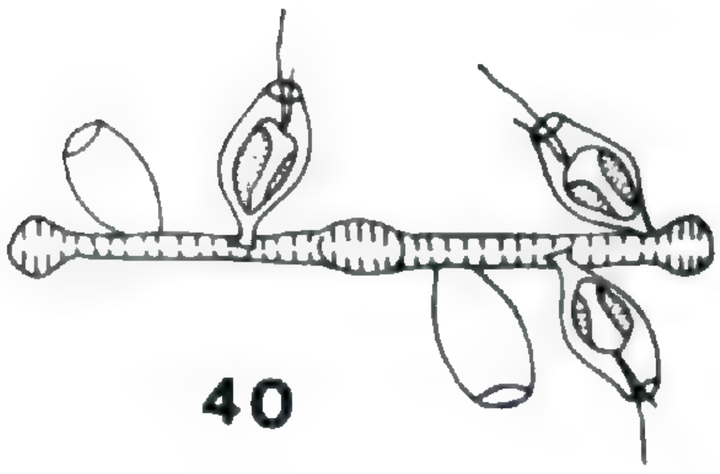

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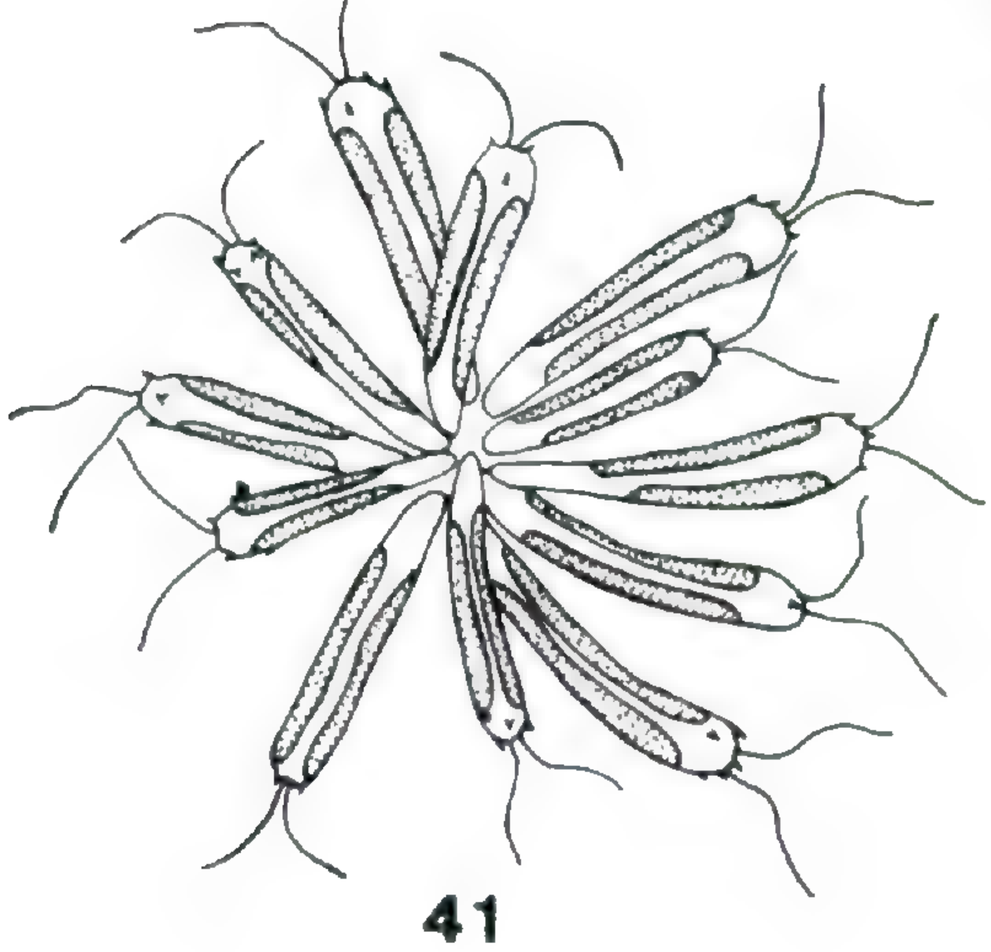

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and November, while at Winnisquam Lake they were most abundant from April-June. The production of statospores coincided with the population peaks.

*__Dinobryon divergens__ Imhof. Less common than *D. bavaricum* or *D. cylindrum*. Present throughout the year at Newfound Lake, but not seen from February to May at Winnisquam Lake. The lorica of *D. divergens* was often difficult to distinguish from that of *D. cylindricum*.

__Dinobryon sertularia Ehrenberg.__ Common throughout the year at both lakes; forming peak numbers in the fall.

**__Dinobryon suecicum__ Lemmermann (Figure 38). Found throughout the year at Newfound Lake. Often difficult to detect because of its very small size; rare.

**__Dinobryon vanhoeffenii__ (Krieger) Bachmann (Figure 37). Found from June to November at Newfound Lake. Its populations showed very rapid pulsations; maximum numbers were recorded in July and August.

**__Epipyxis tabellariae__ (Lemmermann) Smith (Figure 40). Found as an epiphyte on *Tabellaria* and *Asterionella* during the fall diatom pulse at Newfound Lake (October and November) and during the spring diatom bloom at Winnisquam Lake; uncommon.

**__Epipyxis utriculus__ Ehrenberg. A common epiphyte on *Tabellaria* at Newfound Lake from August to November.

__Mallomonas acaroides__ Perty. Only found during October and November at Newfound Lake; rare.

**__Mallomonas elegans__ Lemmermann. Abundant during the spring phytoplankton pulse (March to May) at Winni-

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Fig. 31. *Peridinium willei* Huitfeld-Kaas, ×500.
Fig. 32. *Peridinium inconspicuum* Lemmermann, ×750.
Fig. 33. *Peridinium limbatum* (Stokes) Lemmermann, ×500.
Fig. 34. *Glenodinium aciculiferum* (Lemmermann) Lindem, ×500.
Fig. 35 & 36. *Dinobryon crenulatum* W. & G. S. West, ×500.
Fig. 37. *Dinobryon vanhoeffenii* (Krieger) Bachmann, ×500.
Fig. 38. *Dinobryon suecicum* Lemmermann, ×1500.
Fig. 39. *Rhodomanas lacustris* Pascher & Ruttner, ×1000.
Fig. 40. *Epipixis tabellariae* (Lemmermann) Smith, ×500.
Fig. 41. *Synura adamsii* G. M. Smith, ×500.
Fig. 42. *Gloeobotrys limneticus* (G. M. Smith) Pascher, ×500.

squam Lake, disappearing quickly after water temperatures increased.

Mallomonas fastigata Zacharias. The most common species of *Mallomanas* found at both lakes. Evident from June to November.

Mallomonas producta (Zacharias) Iwanoff. Relatively common at both lakes from June to November; found occasionally during the winter at Winnisquam Lake.

Mallomanas pseudocoronata Prescott. Common throughout the year at Newfound Lake.

Mallomonas tonsurata Teiling var. **alpina** (Pascher and Ruttner) Kuetzing. Common throughout the year at Newfound Lake. During the fall and the period of ice cover it occurred in maximum numbers near the surface, while during the summer it was most abundant at 10 and 15 meters.

Synura adamsii G. M. Smith (Figure 41). Found at Winnisquam Lake from May to November; rare.

Synura uvella Ehrenberg. Very common throughout the year at both lakes. However, it was more abundant at Winnisquam Lake where it formed maximum numbers during the summer and fall. It was generally found below 5 meters.

Uroglenopsis americana (Calkins) Lemmermann (Figure 13). Common from June to November at Newfound Lake. Large pulses of populations developed suddenly in August, 1966 and July, 1967 and disappeared just as quickly. It was much less common at Winnisquam Lake and was only found in small quantities from May to August, 1967.

BACILLARIOPHYCEAE

Asterionella formosa Hass. Very common at both lakes. Large populations were evident in the spring (April) and fall (November) at Winnisquam Lake. Such a periodic cycle was less evident at Newfound Lake because the diatom was not as abundant. Large populations were recorded under ice cover.

Asterionella formosa var. **gracillima** (Hantz) Grun. Much

less common than the typical species; only evident from February to early May. The cells were often in chain-like colonies, as illustrated by Huber-Pestalozzi (1942).

*__Cyclotella bodanica__ Eulenst. The most common species of *Cyclotella* found at Newfound Lake. Evident throughout the year and reaching maximum numbers during the summer. The maximum quantities were found at 10 meters and below.

*__Cyclotella compa__ (Ehrenberg) Kuetzing. Common throughout the year at both lakes; maximum numbers were evident during the spring and late fall between 5 and 10 meters.

*__Cyclotella glomerata__ Bachmann. Found at Newfound Lake when the water temperatures were quite low. Most abundant from February to early May, but even then it was uncommon.

*__Cyclotella stelligera__ Cleve and Grein. Found at Winnisquam Lake from September to November; rare.

__Cymbella ventricosa__ Kuetzing. Found at Winnisquam Lake during the period of the spring overturn (April and May). It is probably not a true planktonic species.

*__Fragilaria capucina__ Desm. Found sporadically at both lakes; uncommon.

*__Fragilaria crotonensis__ Kitton. Very common throughout the year at both lakes. However, it was more abundant at Winnisquam Lake where it formed maximum numbers during November, 1966 and July to August, 1967. The largest concentration of populations occurred between 3 and 5 meters.

*__Melosira ambigua__ (Grun.) Mueller. Abundant throughout the year at both lakes. The maximum populations were evident during the spring and fall at Newfound Lake, while during the fall at Winnisquam Lake.

*__Melosira distans__ (Ehrenberg) Kuetzing. Found throughout the year at Newfound Lake; always in very small quantities.

*__Melosira italica__ (Ehrenberg) Kuetzing. Very abundant throughout the year at Winnisquam Lake. Maximum

numbers were found from February to May with the largest peak occurring at the time of the spring overturn. Lesser peaks occurred during the fall overturn (October and November). During the spring and fall overturn populations were evenly distributed throughout the water column, while throughout the rest of the year they steadily settled out of the photic zone. Such observations are similar to those made by Lund (1954, 1955) upon *Melosira italica* (Ehrenberg) Kuetzing subsp. *subartica* O. F. Müller.

*__Melosira italica__ var. __tenuissima__ (Grun.) Mueller (Figures 8 & 9). Very common at Winnisquam Lake throughout the year. The development of this variety was similar to the typical plant, with maximum development occurring in the spring. Auxospores were observed during April, and they were present until early June, when many appeared to be germinating.

*__Meridion circulare__ var. __constrictum__ (Ralfs) V. H. Present in small numbers during the spring overturn at Winnisquam Lake. Probably not a true planktonic species.

*__Rhizosolenia eriensis__ H. L. Smith. Very common at Newfound Lake during July and August. Its maximum abundance was evident below 10 meters. It was sporadically present at Winnisquam Lake; being most conspicuous during the winter and spring. The morphological variation of the plant is extremely great.

*__Synedra ulna__ (Nitz.) Ehrenberg. Common throughout the year at both lakes. However, it was more abundant at Winnisquam Lake, where it reached its maximum peaks during May and June.

*__Tabellaria fenestrata__ (Lyngbye) Kuetzing. Common throughout the year at both lakes; but most common at Winnisquam Lake. Tending to reach maximum peaks after all other diatoms in the spring, and before all others in the fall.

*__Tabellaria flocculosa__ (Koth) Kuetzing. Common through-

out the year at Newfound Lake. Only occasionally observed at Winnisquam Lake from April to June.

Dinophyceae

Ceratium hirundinella (O. F. Mueller) Dujardin. Common at both lakes from April to November. All specimens were of the form *robustum* as described by Huber-Pestalozzi (1950).

***Glendodinium aciculiferum** (Lemmermann) Linden. (Figure 34). A few specimens were observed in each collection made at Winnisquam Lake from March to early June; rare. The alga has the characteristic three spines on the hypovalve.

***Gonyaulax palustris** Lemmermann. Common at Newfound Lake from February to early June.

***Gymnodinium fuscum** (Ehrenberg) Stein. Present sporadically throughout the year at Newfound Lake.

***Gymnodinium palustre** Schilling. Found at Newfound Lake in February, March and April; rare.

***Peridinium cinctum** (O. F. Mueller) Ehrenberg. Found sporadically throughout the year at both lakes; never in any great abundance.

***Peridinium inconspicuum** Lemmermann (Figure 32). Common at Newfound Lake from June to October; maximum numbers were evident during August. Most of the populations were restricted to the 10 meter collections.

***Peridinium limbatum** (Stokes) Lemmermann (Figure 33). The dominant dinoflagellate at Newfound Lake. Found throughout the year, but reaching maximum numbers in the fall. It was found in very small quantities throughout the year at Winnisquam Lake, and was evenly distributed throughout the water column.

***Peridinium willei** Huitfeld-Kaas (Figure 31). Common throughout the year at Newfound Lake. Maximum numbers were recorded during the winter.

***Peridinium wisconsinense** Eddy. Common from July to October at Newfound Lake. Maximum numbers were evident during September and October.

CRYPTOPHYCEAE

*__Cryptomonas erosa__ Ehrenberg. Common throughout the year at Newfound Lake.

*__Cryptomonas erosa__ var. __reflexa__ Marsson. A few specimens of this variety were found from February to early June at Newfound Lake.

*__Cryptomonas marssonii__ Skuja. Found sporadically from July to November at both lakes.

__Cryptomonas ovata__ Ehrenberg. Very common throughout the year at both lakes, but more abundant at Winnisquam Lake. The maximum populations were reached in the spring and fall.

**__Rhodomonas lacustris__ Pascher and Ruttner (Figure 39). Abundant throughout the year at both lakes; with peaks in the spring and fall. Very large numbers were found at Winnisquam Lake in April and May.

SUMMARY

A total of 185 taxa of fresh algae (primarily phytoplankton) were identified at Winnisquam and Newfound Lakes, New Hampshire. Of these, 149 are presumed to be newly published records for New Hampshire and 45 are presumed to be new records for New England.

Of the 142 taxa recorded at Winnisquam Lake, 85 were found exclusively at this location. The green algae contributed the greatest number of species, but the bulk of the standing crop was composed of blue-green algae. During the summer the phytoplankton flora was primarily composed of members of the Chlorophyceae and Cyanophyceae. Members of the Bacillariophyceae, Chrysophyceae and Chlorophyceae (mainly desmids) contributed the largest number of species during the spring and fall. Diatoms were the major component of the winter flora.

A total of 100 taxa were recorded at Newfound Lake, and 43 of these were found exclusively at Newfound Lake. The largest number of species were green algae. During the summer and fall the phytoplankton was primarily composed of members of the Cyanophyceae, Chlorophyceae

(especially desmids) and Chrysophyceae. The diatoms and the golden-brown algae contributed the largest number of species during the winter and spring.

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MAGNOLIA TRIPETALA L. AND ARALIA SPINOSA L. IN ST. LOUIS COUNTY, MISSOURI: Steyermark, in his monumental *Flora of Missouri* (Iowa State University Press, Ames, 1963), discusses at length the possibility of the natural occurrence of *Magnolia tripetala* L. in Missouri, and presents convincing arguments that previous ascriptions of this species to Missouri are based on mislabelled specimens (p. 670). On 7 June 1968, while collecting in a second-growth deciduous woods of about 100 acres in Creve Coeur, St. Louis County, Missouri, I found a single tree with multiple large trunks from the base which is undoubtedly *M. tripetala*. The tree is growing deep in the woods, and gives every appearance of being native — I have located no cultivated specimens in the adjacent city area, and the trunks are 20 to 30 feet high, indicating that the tree could scarcely have been transplanted to such a site; moreover, houses have only recently been built in this area, and the woods remain somewhat isolated and remote from major disturbance. The stand of trees, known locally as the Tegethoff property, is bounded grossly by I-244 on the east, Mason Road on the west, Halsgame Lane on the north, and Hubler Road on the south. Three specimens of leaves, "cones", and twigs are deposited as vouchers in the herbarium of Wisconsin State University-Oshkosh (Harriman 3071).

In the same area, about 100 yards south of the *Magnolia* tree, there occurs a large grove of *Aralia spinosa* L. Steyermark reports that this tree occurs generally through southeastern Missouri (p. 1112), but admits the plant to the native flora of St. Louis County only doubtfully. Again, I was unable to find any cultivated specimens of this tree in the vicinity, and the area in the woods where the tree occurs is also quite remote from roads, paths, and houses; it therefore appears definitely to be native to St. Louis County, its northernmost station in Missouri. A specimen of one large leaf, mounted on three sheets, is deposited

in the herbarium, Wisconsin State University-Oshkosh (Harriman 3085).

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ERAGROSTIS DOMINGENSIS (PERS.) STEUD. NEW TO THE UNITED STATES[1]

This grass was encountered during a collecting trip to the upper Florida Keys in the late summer of 1968. The discovery was timely for its inclusion in the "Subtropical Flora of Florida."

Perennial by short rhizomes. Culms 0.6-1.5 m tall, erect, rigid, relatively stout, 3 mm in diameter at lower internodes. Basal leaves few per culm; sheaths of previous years 5-8 mm wide at base, persistent, silvery on adaxial surface. Nodes purplish-brown. Culm leaves 3 or more with overlapping, pale green prominently veined sheaths, pilose at summit; ligule a fringe of hairs less than 0.5 mm long; the base of blade banded within, with silky puberulence; blades 2-7 mm wide, flat, linear, long-attenuate, involute at tips; midrib white, veins on adaxial surface scaberulous. Panicle 3-5.5 dm long, strict; the lower 1 or 2 racemes solitary, distant; the upper, fascicled; rachis and raceme branches wiry, glabrous. Spikelets short-pedicelled, 7-12(18)-flowered, glabrous; glumes 1 mm long, acute; lemmas 1.5-1.8 mm long, ovate-acute, with hyaline margins, deciduous with the fruit; paleas persistent, nearly as long as the lemmas, scaberulous on the veins. Fruit amber, 0.6-0.8 mm long, oblong in outline, slightly contracted to apex, truncate-oblique at base; the body patently longitudinally striate.

The grass was discovered on Plantation Key, Monroe County, Florida. Collection L31623 was made August 27, 1968, from a small colony in a transition zone of dune sand and grassy berm along the old road, east side of US #1. Its strict habit, bony hardness of the culm, and narrow, elongate panicle are outstanding differentiating characters.

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[1]Contribution no. 43 from the Botanical Laboratories, University of South Florida, Tampa.

The author is indebted to Dr. LeRoy H. Harvey who, during a recent visit to the University of South Florida Herbarium, named the plant by sight in a stack of *Eragrostis* collections.

Known to occur on beaches, rocky soil near the coast, Cuba, Jamaica, Hispaniola, Leeward and Windward Islands, and, according to Dr. Harvey, Veracruz, Mexico.

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AN INCORRECT CORRECTION. In a recent Rhodora article the use of connecting vowels in epithets of Latin origin was examined. *Penstemon tubaeflorus* was corrected to *Penstemon tubiflorus*. Recommendation 73G in the International Code of Botanical Nomenclature, however, clearly states that irregular forms can be used to reveal etymological distinctions and that when such irregularities occur in the original spelling of existing compounds, they should be retained. Thomas Nuttall intentionally used the *ae* spelling to indicate that the flowers were shaped like a horn *(tuba)* rather than like a waterpipe *(tubis)*. It is truly a happy occasion when one discovers that his botanical predecessors were not altogether as illiterate as he has sometimes supposed.

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A RE-EVALUATION OF CUPHEA, SECT. LEPTOCALYX, SERIES BUSTAMANTAE

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In the course of studying the collections of *Cuphea* from Mexico deposited in the Natural History Museum in Paris, type material was found representing four of the five species of Sect. Leptocalyx, the third series. With the loan of additional types from Kew and Halle herbaria it was possible to compare authentic material of all species in this poorly known group. The species involved were *C. bustamanta*, *C. calaminthifolia*, *C. corniculata*, *C. debilis*, and *C. imberbis*. The latter was regarded by its author as a member of Sect. Heterodon, but as will be evident from the morphology, it clearly belongs to Sect. Leptocalyx.

The first named species, *Cuphea bustamanta*, is frequently collected in pine-oak woods in Mexico and is easily recognized. It is fully described here for the first time and the position of an intraspecific taxon is re-evaluated. The remaining species are known only from type material and a few additional collections. Distinctions between them as based on the protologues are minor and examination of the types confirms the suspicion that *C. calaminthifolia*, *C. corniculata*, *C. debilis*, and *C. imberbis* represent a single taxon. They are united under the earliest epithet, *calaminthifolia*.

The series, established by Koehne (Fl. Bras. 13(2) : 236. 1877) was numbered but unnamed. Hence, the name *Bustamantae* is proposed, based on the type species of the series. The series is a particularly distinctive one within the genus, immediately recognizable by its slender trailing habit, transversely oriented (at right angles to the stem), 2-armed hairs, and 9-staminate flowers. Because Koehne's description of the series is very brief and fails to mention a number of prominent characters which the species share, including the characteristic transverse malphigaceous-like hairs, an expanded diagnosis is given below.

Cuphea, Sect. Leptocalyx, Series **Bustamantae** S. A. Graham, ser. nov. Type: *C. bustamanta* Lex.
Series 3 Koehne, Fl. Bras. 13(2): 236. 1877.

Herbae graciles repentes, verisimiliter perennes, ubique secus caules prostratos radicantes. Caules, petioli, et pedicelli pilis transversalibus malpighiaceis praeditis. Folia membranacea, ovato-elliptica apice acuto ad acuminato. Inflorescentia racemosa, foliata, flores paucis. Calyx gracilis, intus glaber, 13-30 mm longus, calcare descendente munitus; appendices lobos aequantes ad superantes multum. Petala 6, unequales, generaliter purpurea. Stamina 9. Ovula (8-)12-18(-23). Discus deflexus in calcare, saepe teretiusculus.

KEY TO THE SPECIES

Calyx bright red with a greenish white area encircling the mouth; lobes of the calyx small, ± equal in size; appendages 2-4 times the length of the lobes; dorsal petals 3-5 mm long, purple-black (rarely yellowish green); ventral petals 1-1.5 mm long, yellowish green, early deciduous. Michoacán to Oaxaca. ..... 1. *C. bustamanta*

Calyx straw-colored to partly or wholly pale reddish purple; dorsal lobe of the calyx distinctly larger than the other five; appendages slightly less than to 3 times the length of the ventral lobes of the calyx; dorsal petals 5-12 mm long, purple; ventral petals 1.5-4 mm long, purple or white. Southern San Luis Potosí to Veracruz, Jalisco, and Michoacán. ..... 2. *C. calaminthifolia*

1. **Cuphea bustamanta** Lex. in LaLlave & Lex., Nov. Veg. Descr. 1: 21. 1824. (Fig. 1a, b.) Type: MICHOACAN: Habitat prope Vallisoletum [Morelia], *LaLlave & Lexarza s.n.* (Holotype, there is no specimen which can be considered an authentic type at G and apparently all original material is lost; Neotype, 29 mi E of Morelia on Mex. 15, 2585 m, 6 Aug 1962, *S. A. Graham* 154 (MICH!) This specimen compares favorably with the protologue and was collected in the same general region as the missing holotype.)

Cuphea reipublicae Rob. & Seat. Proc. Am. Acad. 28: 106. 1893. Type: MICHOACAN: Near Patzcuaro, 28 Jul 1892, *C. G. Pringle* 4142 (Holotype, GH; isotypes, P! US! VT). The type number was incorrectly cited in the protologue as Oct 1892, *Pringle* 4112.

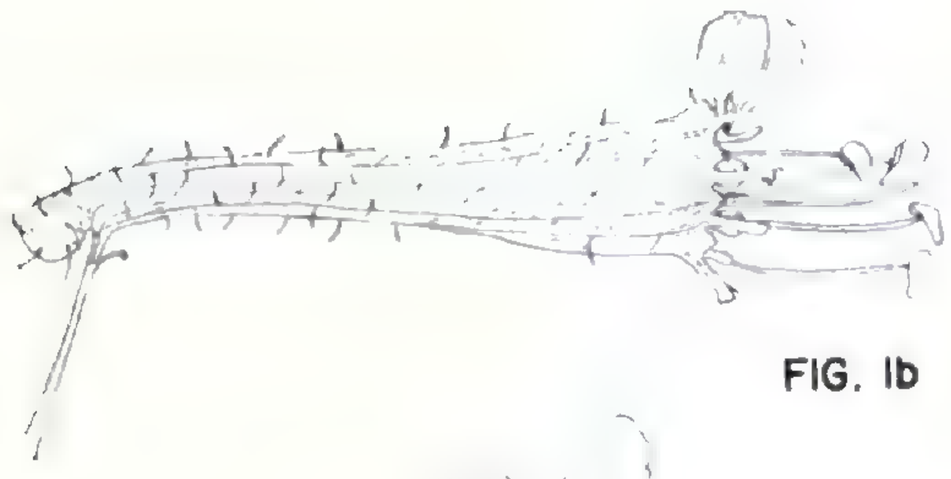

FIG. 1b

FIG. 1a

FIG. 2

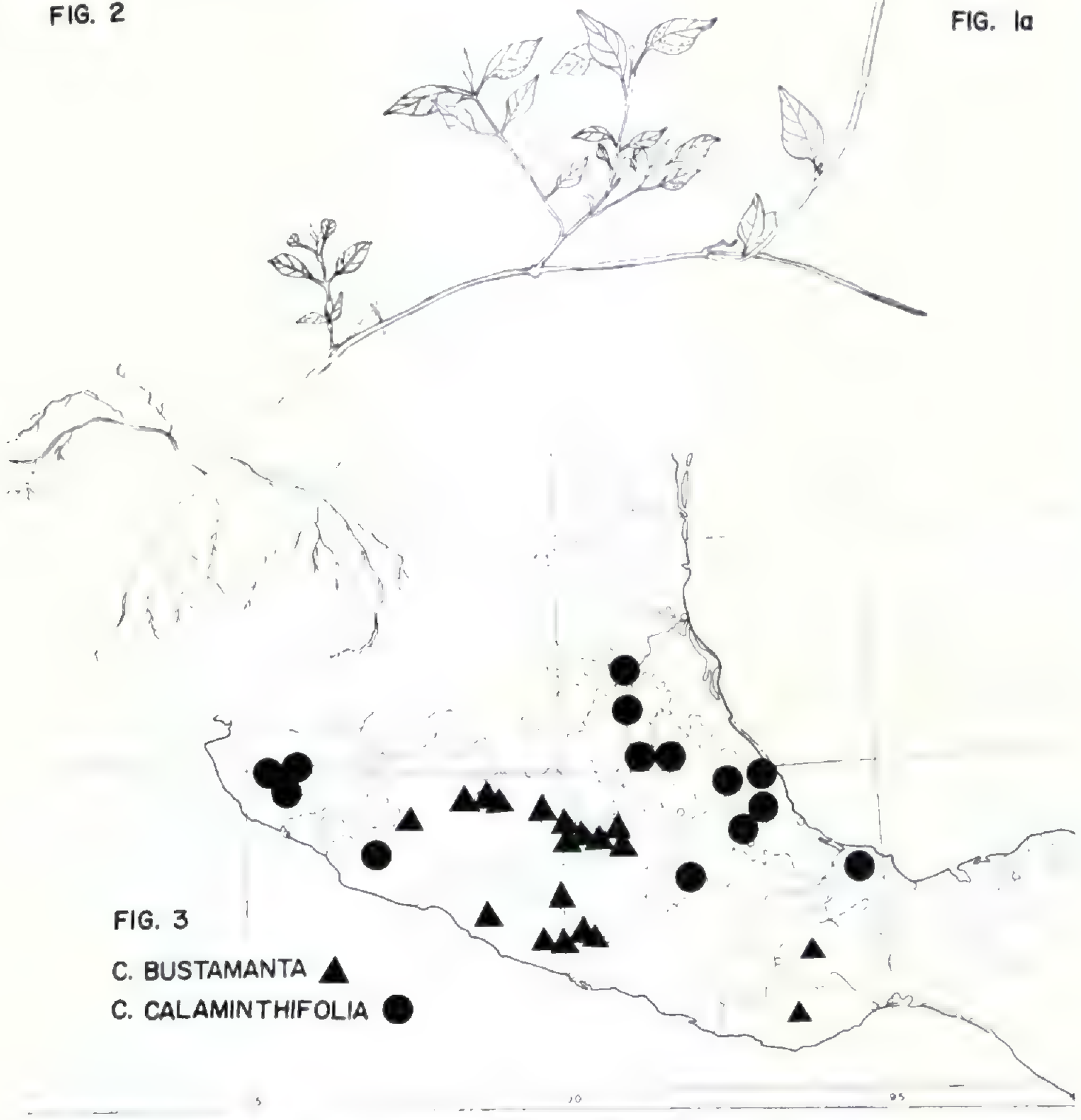

Fig. 1. *Cuphea bustamanta* Lex. 1a, habit ×½, *(Graham 53)*; 1b, flower ×1¼, *(Graham 154)*. Fig. 2. *C. calaminthifolia* Schlectd., flower ×1¼, *(Anderson & Laskowski 3819)*. Fig. 3. Distribution of species in Mexico, each symbol representing one or more collections at that locality.

According to Davis (H. B. Davis, Life and Works of Cyrus Guernsey Pringle, p. 100) and the Pringle Herbarium (pers. comm.), *Pringle* 4112 is *Euphorbia torrida* DC., collected 17 Jun 1892, at Rascon, San Luis Potosí and *Pringle* 4142 is *C. reipublicae* Rob. & Seat., collected 28 Jul 1892 by brooks near Patzcuaro. All type material including the specimen presumably studied by Robinson and Seaton at GH bears the same printed label numbered 4142. Although Pringle also was in Patzcuaro in October, his collection numbers there were mainly 4200's and 4300's and no mention is made in his diary of recollecting no. 4142, nor are any specimens known to bear the data cited in the protologue.

Cuphea bustamanta forma *reipublicae* (Rob. & Seat.) Koehne, Bot. Jahrb. 23 (Beibl. 57): 29. 1897.

Parsonia bustamanta (Lex.) Standl. Contr. U.S. Natl. Herb. 23: 1021. 1924.

Herbs, slender, trailing, probably perennial, with fibrous, adventitious roots occurring along the length of procumbent stems up to 1 m long; stems bearing erect to decumbent branches up to 40 cm tall, covered with dense, minute, two-armed, colorless, transversely oriented hairs and a row of longer, non-branched hairs. *Leaves* ovate to elliptic, the blades 20-50 mm long, 10-28 mm wide, the apex acuminate, the base obtuse to generally attenuate; petioles 5-15 mm long, bearing transverse two-armed hairs; blades thin, dark green above, pale beneath, both surfaces bearing minute, stiff hairs mixed with longer, weak hairs, the long hairs on the lower surface sometimes confined to the margins of the leaf; leaves scarcely diminishing in size toward the apex of the stem. *Inflorescence* a leafy, few-flowered raceme; flowers 1 per node, interaxillary on bibracteolate pedicels 4-13 mm long; bracteoles linear, green, 1-3 mm long. *Calyx* slender, nearly straight, 22-30 mm long including a downward curving, basally rounded spur 2-3 mm long, bright red except for a greenish white area encircling the mouth of the calyx; externally bearing short, stiff, colorless,

distally oriented hairs mixed with scattered, longer, colorless, weak hairs, the latter most concentrated at the proximal end of the calyx; internally glabrous, neither bialate nor vesiculate; mouth of calyx slightly flaring, oblique with the dorsal side appearing shorter; neck of the calyx not contracted in fruit. Lobes of the calyx small, exceeded by linear, green appendages, 2-4 times the length of the lobes. *Petals* 6, the two dorsal ones obovate, generally purple-black, 3-5 mm long including a claw 1 mm long, (rarely yellowish green, then 1-2 mm long), subtended at the base by a flattened, yellow scale, free along one edge and included within the calyx; ventral petals yellowish green, obovate, to oblong, ca. 1 mm long, early deciduous. *Stamens* 9, mostly exserted, glabrous, the filaments and anthers deep purple. *Pollen* oblate, distinctly triangular in polar view; tricolporate, the pores equatorially arranged, equidistant, not protruding; syncolpate; exine tectate, finely and uniformly striate over the entire surface of grain, striae extending to the poles; diameter 37 μ. *Gynoecium* with punctate to capitate sigma and exserted, glabrous style; ovules 12-15 (-23 fide Koehne); seeds lenticular, orbicular in outline, 2 mm in diameter. *Disc* horizontal in spur, 1.5 mm long, thick, nearly terete, slightly tapering to a blunt apex. $n = 12$.

Growing generally on steep, moist banks and along streams in pine-fir-oak forests at elevations from 1800-3600 m. Known from Michoacán to Oaxaca (Fig. 3). According to LaLlave and Lexarza, flowering throughout the year.

The species may be recognized by the long, slender, red calyx with linear, green appendages which markedly exceed the calyx lobes, its 9-staminate condition and the procumbent stems and branches bearing transverse two-branched hairs.

Although Koehne, in his monograph of *Cuphea* (1903, p. 171) cites *C. reipublicae* Rob. & Seat. as *C. bustamanta* var. *reipublicae* (Rob. & Seat.) Koehne, he actually made the combination under the rank *forma*. The type of the form differs from typical *C. bustamanta* only in its yel-

lowish green, rather than purple dorsal petals. Other character differences cited by Koehne were the 1 m height of the plant and the "somewhat broader" leaves lacking long (hispid) hairs in the middle of the ventral leaf surface. Examination of two isotypes reveals that the "height" of 1 m was actually the length of the procumbent, adventiously rooted main stem, the height of the erect branches being 15-40 cm, which is typical of the species. The width of the leaves falls within that of typical *C. bustamanta,* and the arrangement of long hairs on the leaf is so variable on specimens examined that this is eliminated as a distinguishing character of the form. In keeping with my taxonomic treatment of variability in other species of *Cuphea,* I choose not to recognize, with formal taxonomic rank, geographically isolated collections such as these which demonstrate but a single, minor character difference.

Additional specimens examined: D.F.: Km. 61, road from Mexico City to Cuernavaca, 4600 m [incorrect?], 11 Aug 1929, *Y. Mexia* 2714 (MICH, MO). GUERRERO: Pie de la Cuesta, Toro Muerto, 2900 m, 17 Dec 1937, *G. B. Hinton* 11084 (US); Galeana, Teotepec, 3000 m, 25 Dec 1937, *Hinton* 11129 (MO, US); Montes de Oca, San Antonio-Buenos Aires, 22 Apr 1938, *Hinton* 14041 (MICH, MO, US); Galeana, Teotepec, 2600 m, 18 Mai 1939, *Hinton* 14275 (MO, US); Mina, Petlacala, Barranca del Ranchito, 1920 m, 1 Jan 1938, *Mexia* 9064 (US); 1960 m, 8 Jan 1938, *Mexia* 9093 (MO, US); Omiltemi, 20 km W de Chilpancingo, 2250 m, 1 Sep 1962, *J. Rzedowski* 15925 (MICH); 5 km W de Camotla, Munic. Chichihualco de Leonardo Bravo, 2600 m, 8 Apr 1963, *Rzedowski* 16403 (MICH); El Asoleadero, 15 km al oeste de Camotla, about 45 km W of Chilpancingo, 2650 m, 2 Dec 1963, *Rzedowski* 18073 (MICH), *C. Feddema* 2850 (MICH); ± 2 km NE del Campamento El Gallo, approx. 17° 28′ N, 100° 13′ W, 2650 m, 27-29 Jan 1965, *Rzedowski & R. McVaugh* 135 (MICH). MEXICO: At state line between Michoacán and México on Mex. 15, 2600 m, 16 Jul 1961, *S. A. Graham* 53 (MICH); Temascaltepec, Comunidad, 2510 m, 6 Jul 1932, *Hinton* 964 (US), *Cajones,* 9 Jun 1935, *Hinton* 7955 (MICH, MO), Pantoja, 9 Sep 1935, *Hinton* 8429 (US); ca. 6 mi S of Tenancingo and 8 mi N of Villa Guerrero on Route 55, 2600 m, 11 Aug 1960, *J. T. Mickel* 689 (MICH); Low hills along Hwy 15, 17 mi E of Zitácuaro, 14 Oct 1962, *W. A. Weber & L. A. Charette* 11879 (MICH). MICHOACAN: Cerro Azul, pres Morelia, 6 Apr 1910, *F. Arsenè s.n.* (P); Temaxcal, 18 Mai 1939, *T. C. & E. M. Frye* 26067 (MO, US); on Mex. 15, 28 mi E of Morelia, 2150 m, 17

Jul 1961, *Graham* 57 (MICH); Zitácuaro, 1800 m, 15 Mai 1938, *Hinton* 11853 (US); Tancítaro, 2050 m, 26 Nov 1940, *Hinton* 15721 (US) (petals all yellow); 6 mi N of Tancítaro, 2615 m, 24 Jul 1940, *W. C. Leavenworth* 335 (MICH, MO); Mt. Tancítaro, 2300 m, 7 Mai 1941, *Leavenworth & Hoogstraal* 4018 (MO), 2425 m, 9 Jul 1941, *Leavenworth & Hoogstraal* 4033 (MO); 40 km east of Morelia, sobre la carretera a Zitácuaro (Km 269), 2600 m, 20 Jul 1964, *Rzedowski & de la Sota* 18361 (ENCB, MICH). MORELOS: Cerro Zempoala, cerca de las Lagunas de Zempoala, 3200-3400 m, 10 Nov 1957, *L. Paray* 2539 (ENCB); Valle del Tepeite, Aug 1932, *E. Lyonnet* 1531 (US); Lagunas de Zempoala, 17 Sep 1938, *Lyonnet* 2457 (US); barranca above Cuernavaca, 2000 m, 31 Jul 1896, *Pringle* 6382 (MO, US), 11 Nov 1902, *Pringle* 9786 (MO, US), 21 Jul 1904, *Pringle* 11981 (MICH, US); near Cuernavaca, 27-30 Mai 1899, *J. N. Rose & W. Hough* 4409 (US). Oaxaca: 1842, *M. Ghiesbreght* 102 (P); vicinity of Cerro Zempoaltepetl, at Patio de Arena, about 5 km E of summit, 2800 m, 9 Aug 1950, *Boone Hallberg* 892 (MICH); Campamento Río de Molino, 4 km SW of San Miguel Suchistepec, 2250 m, 21 Sep 1965, *Rzedowski* 21061 (MICH). Locality unknown: Mexique?, 1826 (Photo, Field Mus. neg. no. 33463 from G at MICH).

2. **Cuphea calaminthifolia** Schlectd., Linnaea **12:** 274. 1838. (Fig. 2.) Type: VERACRUZ: Cuesta grande de Chiconquiaco, Sep 1829, *Schiede s.n.* (Holotype, HAL!; isotypes, Photo of CGE isotype, MICH neg. no. 1732, 1733!, P!).

Cuphea corniculata Koehne, Fl. Bras. 13(2): 236. 1877. Type: HIDALGO?: between Tampico and Real del Monte near Pachuca, *Berlandier* 362 (Holotype, probably was at Berlin; isotype, P!). No specimen was cited in the protologue but Koehne later (Bot. Jahrb. **2:** 415. 1882) gave the locality of the species as "Inter Tampico et Real del Monte!", then in his monograph (Pflanzenr. 216. 171. 1903) cited the single collection, *Berlandier* 362 from "Zwischen Tampico und Real del Monte bei Pachuca."

Cuphea debilis Hemsl., Diag. Pl. Nov. Mex. 3: 51. 1880, (amplified in Hemsl., Biol. Centr. Am. 5: 439. 1880). Type: VERACRUZ: Jalapa, *Dr. Coulter* 156 (Holotype, K!).

Cuphea imberbis Rose in Koehne, Bot. Jahrb. **41:** 94. 1907. Type: HIDALGO: wet banks, Trinidad Iron

Works, 29 Jul 1904, C. G. *Pringle* 8979 (Holotype, US!; isotypes, MICH! Photo of MSC isotype, MICH neg. no. 1039, 1040! MO! P!).

Herbs, slender, trailing, probably perennial, with weak, decumbent stems 20-65 cm long bearing adventitious roots along their length, and covered with minute, two-branched, colorless, transversely oriented hairs and longer, weak, non-branched hairs, the hairs especially dense on younger portions. *Leaves* broadly ovate to narrowly elliptic, the blades 15-60 mm long, 8-30 mm wide, the apex acuminate, the base attenuate; petioles 4-10 mm long, bearing same hair types as the stem; blades thin, dark green above, pale gray-green below, both surfaces bearing minute stiff hairs mixed with sparse to dense, longer, weak hairs; leaves scarcely diminishing in size toward apex of the stem. *Inflorescence* a leafy, few-flowered raceme; flowers 1 or 2 per node, interaxillary (or occasionally axillary) on bibracteolate pedicels 7-15 mm long; bracteoles linear, green or purple, less than 1 mm long. *Calyx* very slender, 12-27 mm long including a downward curving, basally rounded spur 1-2(-3) mm long, calyx at anthesis 1.5 mm wide, pale reddish purple to straw-colored; externally bearing dense, short, stiff, colorless, distally oriented hairs and scattered longer, weak, colorless or purple hairs, the latter often more concentrated at the proximal end of the calyx; internally glabrous, neither bialate nor vesiculate; mouth of the calyx slightly flaring, not oblique; neck of the calyx scarcely contracted in fruit. Upper lobe of the calyx broadly deltoid, apparently deep purple within, 1.5 mm long, 2 mm wide, distinctly larger than the other five lobes which are less than 1 mm long and ca. 1 mm wide; appendages oblong to spathulate, slightly less than to three times the length of the small calyx lobes. *Petals* 6, greatly unequal, the two dorsal ones purple, obovate to oblong, (6-)8-12 mm long, tapering basally to a very short claw, subtended at the base by a thickened scale which is obliquely truncate to corniform along the free edge and included within the calyx; ventral petals purple to pale purple or white, 1-2(-6)

mm long, obovate. *Stamens* 9, 3 or 4 (-6) exserted, glabrous. *Pollen* oblate, triangular to oval-triangular in polar view; tricolporate, the pores equatorially arranged, equidistant, not protruding; syncolpate; exine tectate, striate over entire surface of grain, striae extending to the poles; diameter 33μ. *Gynoecium* with capitate stigma and exserted, glabrous style; ovules (8-) 12-18; seeds dark brown, lenticular, nearly orbicular in outline, 2 mm long, 1.75 mm wide. *Disc* horizontal in spur, ca. 1 mm long, thick, nearly terete, slightly tapering to a blunt apex.

An infrequently collected species, ranging from southern San Luis Potosí to Veracruz on the east and presently known from Jalisco and northern Michoacán in the western mountains (Fig. 3). Its habitat is identical to that of *C. bustamanta*, though the elevations at which it grows, 1450-2500 m. are somewhat lower. It has been collected in bloom from May through December.

Described by Schlectendal as not a very elegant plant, its distinguishing features are the weak trailing stems with transversely oriented malpighaceous-like hairs, slender, often colorless to pale reddish purple calyx with large dorsal calyx lobe, 9 stamens, and 6 unequal deep purple to pale or white petals. Vegetatively, it is very similar to *C. bustamanta* but the calyx of that species is red, lacks the large dorsal calyx lobe, and has smaller purple-black dorsal petals. In Koehne's key (1903) the species are contrasted by axillary vs. interaxillary position of the flowers. Examination of specimens has shown, however, that the position of the flower is generally interaxillary in both species, so that they cannot be distinguished by this character.

Koehne, in initially describing *Cuphea corniculata*, suggested it might be merely a variety of *C. calaminthifolia*. He later reiterated this suggestion (Bot. Jahrb. 2: 414. 1882), but still later, in his monograph of the genus, omitted comment regarding such a relationship. The features of *C. corniculata* which should distinguish it from *C. calaminthifolia* are more a matter of semantics than actual character differences. Examination of type material

shows that the obovate dorsal petals of *C. calaminthifolia* and the cuneate oblong petals of *C. corniculata* are essentially the same shape, those of the former varying from obovate to oblong, and the remaining petals on the isotype of *C. corniculata* being oblong. The only other character which separates the species is the shape of the scale. There is one flower on the isotype of *C. corniculata* and of the two scales present there, one terminates in a short horn-like process, while the other may be classified with the scales of *C. calaminthifolia* as obliquely truncate in shape. The other variable characters of the two species are identical, overlap, or are insignificantly different. Table I lists the characters taken from the type material representing this taxon and the others to be discussed in which variation is found. Characters not included on the table are considered identical on all the specimens examined. Color of the calyx and petals varies among the types but could not be determined with certainty, due to the age and poor preservation of the specimens.

Hemsley, in describing *Cuphea debilis*, suggested it was closely allied to *C. calaminthifolia*, but saw no specimens of the latter. The type of *C. debilis* consists of one whole and one partial stem, both much wilted at the time they were pressed, and each bearing a single flower. The general dimensions of the type are indeed smaller than the other taxa included within *C. calaminthifolia*, but the entire aspect of the type is a depauperate one. The differences between *C. debilis* and *C. calaminthifolia* lie in the former's generally smaller dimensions, fewer ovules, and the relatively long appendages of the calyx. The length of the appendages, as can be seen from the comparative table, falls within the range of variation of the species. The small dimensions and ovule number may be attributed to poor growing conditions of the plant, though even if considered typical of the population are still within reasonable limits of size variation for the species.

The species *Cuphea imberbis*, on the basis of its enlarged dorsal lobe, was considered by both Rose and Koehne to

Table I. Comparison of Variable Characters From Type Material

	calaminthifolia	*corniculata*	*debilis*	*imberbis*
Height	20-60 cm	50-65 cm	30 cm	30-40 cm
Leaves	15-32 mm long 8-12 mm wide	40-60 mm 15-22 mm	17-22 mm 7-10 mm	25-60 mm 12-30 mm
Petioles	4- 5 mm long	5-10 mm	5- 7 mm	5-10 mm
Pedicels	7-11 mm long	8-10 mm	12-15 mm	6-10 mm
Calyx	15-25 mm long	15-17 mm	12-15 mm	17-20 mm
Appendages	ovate, equal to slightly exceeding lobes	oblong, 2× longer than lobes	oblong to spathulate 2-3× longer than lobes	oblong to spathulate 2-3× longer than lobes
Dorsal Petals	obovate 6-8.5 mm long	oblong 10 mm long	obovate 5-6 mm long	obovate-oblong 10-12 mm long
Ventral Petals	3-6 mm long	1.5-2 mm	1-2 mm	1.5-2 mm
Scales	obliquely truncate	corniform-obliquely truncate	obliquely truncate or rounded	obliquely truncate
Ovules	13-18	14	8	12

belong to Sect. Heterodon. However, the combination of trailing habit, long calyx, 9 stamens, transversely oriented malpighaceous-like hairs, and pollen morphology places it more naturally in Sect. Leptocalyx, series Bustamantae. The characters from the type of *C. imberbis* fall within the range of variation displayed by the other types studied and the species is unquestionably synonymous with *C. calaminthifolia.*

The pollen morphology displayed by *Cuphea calaminthifolia* deserves special comment. As recorded elsewhere (Graham & Graham, 1967) *Cuphea* is a distinctly eurypalynous genus with species frequently having a unique morphology. The section Leptocalyx palynologically is a natural one, characterized by triangular to oval-triangular, syncolpate, much striated pollen with non-protruding or slightly protruding pores. Section Heterodon, though more diverse in pollen characters, has oval-triangular to orbicular, non-syncolpate or syncolpate pollen with striae mostly concentrated around the highly protruding pores. The pollen of *C. calaminthifolia* is definitely of the type found only in Sect. Leptocalyx and substantiates the species placement there, rather than in Sect. Heterodon. Pollen morphology further suggests that the "key" character of Sect. Heterodon, the large dorsal calyx lobe, does not delimit a natural group of species but may well have arisen more than once in the genus in distantly related taxa (also cf. *C. koehneana* and *C. paucipetala* in Graham, 1968, p. 5). Thus taxa with this character need to be evaluated from the standpoint of their total morphology for a more natural taxonomic placement.

Additional specimens examined: HIDALGO: Km 254, 14 Jul 1968, *Irma Schnooberger* 7999 (MICH); Km 310.5, between Zimapan and Tamazunchale, 15 Jul 1948, *Schnooberger* 8036A (MICH). JALISCO: Cerro del Muñeco or Sierra de Manantlán, 30-35 km SE of Autlán, 2100-2450 m, 29 Sep 1966, *W. R. Anderson & C. W. Laskowski* 3819 (MICH); Sierra de Manantlán, 15-20 mi SE of Autlán, about 2 mi from Aserradero San Miguel Uno, 2250-2400 m, 4-5 Nov 1952, *McVaugh* 13867 (MICH, US); Near Santa Mónica, probable lat. ca. 20° N Long., ca. 104°, 30′ W, 1950-2050 m, 12-13 Nov. 1952, *McVaugh* 14050 (MICH, US); 6-7 road-miles NW of San Miguel de la Sierra

(40-50 km, airline, west of Ayutla), 1900-2000 m, 4 Nov 1962, *McVaugh* 22063 (MICH); mountains east of Mamantlán, about 15 mi S-SE of Autlán by way of Chante, ca 2500 m, 25 Jul 1949, *R. L. & C. R. Wilbur* 1832 (MICH), 27 Jul 1949, *Wilbur & Wilbur* 1878 (MICH). MICHOACAN: Dist. Coalcomán, Sierra Torricillas, 2360 m, 12 Oct 1938, *G. B. Hinton* 12354 (MICH, MO, US), Jul 1939, *Hinton* 15021 (US), Barroloso, 2250 m, 21 Oct 1939, *Hinton* 15355 (MICH, MO, US). PUEBLA: Teziutlán, 1846 m, 20 Dec 1963, *R. C. Koeppen s.n.* (MICH); Chinantla, Mai 1841, *Liebmann* 3795 (US). SAN LUIS POTOSÍ: 5 km NW de Ahuacatlán, Munic. de Xilitla, sobre el camino a El Lobo, 1450 m, 30 Aug 1957, *J. Rzedowski* 9256 (ENCB). VERACRUZ: San Miquel, Jalapa, 2000 m, 3 Jun 1938, *E. K. Balls* 4719 (US); Coscomatepec, 10 Mai 1937, *E. Matuda* 1306 (MICH), Cerro Punta Coscomatepec, 10 Mai 1937, *Matuda* 1507 [1307?] (MICH); prope San Andres, Aug 1828, *C. J. W. Schiede s.n.* (HAL); prope Jalapam, Mai 1829, *Schiede s.n.* (HAL), Jun 1829, *Schiede s.n.* (HAL).

The author gratefully acknowledges the aid of the curators of the herbaria cited for the loan of valuable type material and information regarding special taxonomic problems. The illustrations are by Susan Cielensky.

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Stuart Kimball Harris

Notice has been received of the death of Dr. Stuart K. Harris on July 30, 1969. A long time active member of the New England Botanical Club and one of its editorial board for nearly as many years, Dr. Harris was President of the Club at the time of his death. A suitable memorial will appear in an early number of Rhodora.

The Editor

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SOME PRELIMINARY STATISTICS OF THE FLORA OF SOUTHERN FLORIDA[1]

ROBERT W. LONG, OLGA LAKELA, and C. ROSE BROOME[2]

We have been working towards the completion of a concise, descriptive manual of the vascular plants of southern Florida for approximately the past four years. Our interest in this work stems from the fact that this part of Florida, unique botanically in the continental United States because of its indigenous tropical flora, does not have an adequate, modern, taxonomic treatment for its plants. The area has not been covered in whole or in part by a manual since Small's Flora of Miami (1913a), Flora of the Florida Keys (1913b), and Manual of the Flora of Southeastern U. S. (1933). It has been our aim to produce a new manual in the shortest possible time; publication cannot be delayed for an indefinite period to allow for detailed, lengthy research that is required to provide solutions for all the taxonomic problems that arise in preparation. A preliminary checklist was published earlier (Lakela and Craighead, 1965) that served as a point of departure for our field and

[1]Contribution no. 42 from the Botanical Laboratories, University of South Florida. We are grateful for the aid furnished by grant no. B-16945 from the National Science Foundation and by the Cooley Botanical Research Fund, University of South Florida. We wish to thank also Dr. Richard A. Howard, Harvard University, for kindly agreeing to read the manuscript.

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herbarium work. Since that time we have placed the revised names and records on "key sort" punch cards; this report is based largely on the statistics derived from an analysis of the flora using this method.

There has been considerable interest in the plant ecology of southern Florida, and many of these studies included lists of plants for the area. Millspaugh's Flora of the Sand Keys (1907) is a detailed ecological and floristic survey of the small islands lying west of Key West. Harshberger (1914) described 16 "formations" of plants and included species' lists in an ecological survey of southern Florida which he defined as the whole of Manatee, De Sota, Lee, Palm Beach, Dade, parts of Osceola, St. Lucie, and Monroe counties, Harper (1927) described southern Florida as that portion of the State extending from the Florida Keys north to Manatee Co. on the west coast, and to Indian River Co. on the east coast, an area of about 17,000 square miles. He listed 430 species for this area. In another ecological survey Davis (1943) limited southern Florida to Charlotte Co., the southern halves of Highland and Okeechobee Cos., St. Lucie Co. and the area south with a total of about 13,000 square miles. He classified the vegetation into 7 main types of communities: high pine forest and scrub, pine flatwoods rockland pine forest and saw palmetto, hammock forests, inland swamps cypress forests and bay tree forests, mangrove swamps and salt marshes, freshwater marshes and wet prairies, and coastal beach and dune vegetation. He identified 850 species of vascular plants including 90 species of trees, 125 species of small trees and shrubs, 130 species of grasses, and 90 species of sedges and rushes. Other noteworthy ecological studies of southern Florida that have species' lists are Phillips (1940), Kurz (1942), Egler (1950), Laessle (1958), and Alexander (1955, 1959).

We have limited our manual range to the southernmost counties in Florida, Collier, Dade, and Monroe, an area of approximately 5000 square miles, because of the general floristic correlations of this part of the State. DeWolf (1964) has estimated that the number of species ought to

be from 400-2000, mostly around 1000 in an area of this size and at this latitude. Our preliminary results show that the total number of species of vascular plants is 1,596. We expect this number to change slightly with revisionary study now in progress. Herbaceous species are 1,032 (about 65% of the total flora), woody species are 564 (about 35%) of the total. From a taxonomic standpoint, the flora is predominately an herbaceous one. The general distribution of taxa is as follows:

	Families	Genera	Species
Pteridophytes	11	36	74
Gymnosperms	4	4	7
Angiosperms	155	556	1515
monocots	29	165	538
dicots	126	391	977
totals	170	596	1596

The largest family in numbers of species and varieties is the Poaceae with 194. Next in size is Asteraceae with 153, Fabaceae with 134, Orchidaceae with 70, Cyperaceae with 62, Euphorbiaceae with 61, Rubiaceae with 40, and Malvaceae with 32.

The relative size and floristic diversity of the vegetation of southern Florida can be noted when one compares these results with the statistics of other floras. Small listed 146 families, 522 genera and 878 species of seed plants in his Flora of Miami (1913a) and 233 families, 1518 genera, and 5557 species of seed plants for the Southeastern States (1933). Comparisons with Small's numbers are not too meaningful since he recognized a number of segregate species, genera, and families that are not generally accepted today. Erdtman West, long-time student of the flora of Florida, estimated the total number of vascular species for the State to be about 3,000 (*in litt.*), an estimate considerably higher than that of Moldenke (1944). Fernald (1950) has 168 families, 1,133 genera, and 5,523 species of vascular plants for Central and Northeastern U. S. and Canada. Leon and Alain (1962) tabulated 181 families, 1,296 genera, and 5,785 species of seed plants for

the Cuban flora with about 50% of the species endemic. D'Arcy (1967) listed 349 genera and 550 species of Dicotyledons for the small island of Tortola, Virgin Islands. Dickson (1953) has 102 families and 415 species on 25 of the Lower Florida Keys, certainly a large number for so small an area. Ward's checklist (1968) listed 318 genera and 1,183 species of lower vascular plants, Gymnosperms, and Monocots for Florida.

ORIGIN OF THE FLORA

The flora is composed of a tropical element and a non-tropical or temperate element. There are 970 species (about 61%) that are generally tropical in distribution, and 626 (about 39%) that are primarily nontropical in origin or distribution. The flora is predominately tropical, and the most significant contribution has come from the Antillean area of tropical America (Howard, 1954); 880 of the 970 species (about 91%) are also found in the West Indies. Of the 1,032 herbs 539 (about 52%) are West Indian or Caribbean in distribution. The woody flora has an even higher percentage of tropical species with 77% of the trees, shrubs, and woody vines of southern Florida being tropical in distribution. The shrubs in particular are predominately Antillean in origin: 250 of 329 species are tropical, and 182 are West Indian species. Most of the 626 non-tropical species are also found in continental United States, and their distribution apparently extends into southern Florida.

The identification and relationships of the endemic flora of Florida has been of concern to botanists for a number of years, and the problems are still largely unresolved (James, 1961). Howard (1954) accepted 385 species of Angiosperms as endemic to Florida. The total number of species and varieties apparently endemic to peninsular Florida that occur in southern Florida is 160, or about 10% of the flora; 139 (87%) are dicots, and 60% of the dicots are herbaceous. We believe this number of endemics is much too high, and our revisionary study has already

reduced this number by demonstrating that some of Small's "endemic" species are in reality West Indian taxa. It is probable that less than 5% of the flora is truly endemic. This ought not to be surprising when one considers that southern Florida is geologically very young even in comparison with other areas in peninsular Florida such as the Lake Wales Ridge that has been continually available to plants since the Pliocene or earlier.

PLANT ASSOCIATIONS

We have been concerned with the plant ecology of the manual range. Particular attention has been given to the identification and the floristic composition of the important plant associations or communities. We have identified 13 principal associations chiefly by means of the local habitat. The numbers of species that may be found in these associations is as follows: scrub vegetation, 76; hardwood hammocks, 306; freshwater swamps, 188; dry pineland, 303; seasonally wet pineland, 361 (floristically the richest association); mangrove, 13; salt marsh, 23; wet prairies, 172; dry prairies, 69; coastal strand, 115; ruderal or disturbed areas, 250; aquatic and marshland, 191; and, marine waters, 5. Many of the species are ecotypically diverse and they can be found in more than one kind of habitat. Additional, fairly well-defined plant communities can be segregated from the major ones listed here by refinements in the classification.

One of the truly difficult problems we have had to deal with in the preparation of this flora is the identification of those species introduced into southern Florida mostly as ornamentals or useful plants that have become established outside of cultivation. If reasonable evidence is available that indicates the plant has escaped and is spreading apparently into new areas, we have included the species as part of the total flora along with the indigenous plants. The introduced and naturalized flora is approximately 250 species, or about 16% of the flora.

We are including chromosome numbers with species'

descriptions where a count has been reported. Chromosome numbers are known for 229 species in the manual range (about 14% of the flora); 190 of these are herbaceous species. Most of the chromosome counts have not been obtained from materials collected in southern Florida, but rather are based on plants of other parts of the species' ranges.

SUMMARY

Good (1964, p 32) places southern Florida in the "Neotropical Kingdom", Caribbean Region together with the West Indies, Bahamas, and Bermudas in his classification of the world's floristic regions. Our preliminary statistics confirm that the flora is predominately a tropical one having close taxonomic relationships with the Antillean area. However, there are significantly more herbaceous species than woody ones. Ecologically, the richest plant associations are the wet or dry pinelands and the tropical hardwood hammocks. The former have high proportions of non-tropical or temperate species, the latter are predominately West Indian in origin.

One of the important by-products of the preparation of a flora treatment such as this has been the identification of a large number of taxonomic problems that merit biosystematic investigation. It is our hope that a new manual of the flora will not only stimulate interest in plants of the area, but also will point out to botanists problems of all kinds for further research in southern Florida.

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ADDITIONS TO THE FLORA OF SAINT LAWRENCE ISLAND, ALASKA

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During the summers of 1966 and 1967, I had the opportunity to spend several months traveling around Saint Lawrence Island by Eskimo skinboat and on foot.[1] During this time, botanical collections were made at all locations on the island known to have been visited by earlier botanists, and a number of hitherto unstudied areas were visited. A total of about 1,100 numbers, representing some 235 species of vascular plants, was collected. A complete set of specimens from these collections will be deposited at the Gray Herbarium. Duplicates will be distributed.

The results of this study are being prepared for publication in the form of a major paper. However, due to the present amount of interest in the Beringean region, it seems appropriate to publish a preliminary report on the new material from Saint Lawrence.

Saint Lawrence Island lies in the northern portion of the Bering Sea, some 200 miles due south of the Bering Strait. The largest of the Bering Sea islands, Saint Lawrence has a land area of approximately 2,000 square miles, roughly equal to that of the State of Delaware. The island's terrain is quite varied. About one half of the land surface consists of poorly drained lowlands which usually contain great numbers of small tundra ponds. There are also large areas of rolling uplands, which include several small mountain ranges. The highest peak on the island rises to about 2,200 feet. Sandy barrier beaches and backshores make up a small but floristically rich part of the total land area of the island.

Saint Lawrence's climate is polar maritime. Summer skies are nearly always overcast, and daytime temperatures seldom rise much above 50° F. During the winter months

[1]This study was supported by grants from the Fernald Fund of the Gray Herbarium, The Institute of Evolutionary Biology at Harvard University, and Sigma Xi.

the warming effect of the surrounding sea is largely abrogated by the presence of pack ice, and mean temperatures are only slightly above 0° F. Storms with high winds are frequent throughout the year. Precipitation, mostly in the form of snow, is heavy. The high winds and heavy snowfall combine to form deep drifts in sheltered areas, and these drifts may persist throughout the summer, even at sea level.

In spite of the island's location some 250 miles south of the Arctic Circle, Saint Lawrence supports a typical arctic tundra vegetation. There are no trees, and many of the shrubby species which are usually an important component of the tundra vegetation in low arctic areas are rare or absent on the island.

Because of its location, Saint Lawrence is of considerable biogeographic interest. The island is located in the center of the area which is believed to have been emergent during the glacial maxima of the Pleistocene epoch, forming the Bering Land Bridge (c.f. Hopkins, 1967). There is some evidence that the most recent land connection between Eurasia and North America was by way of Saint Lawrence Island, rather than across the narrowest part of the Bering Strait (Hopkins, loc. cit.). The land bridge was subject to only local glaciation during the Pleistocene, and the entire Beringean Region undoubtedly served as a refugium for many elements of the arctic and boreal biota during the glacial maxima (Hultén, 1937).

Hultén (1941-1950) lists specimens of some 190 species of vascular plants as having been collected on Saint Lawrence Island. In a later volume (Hultén, 1968) additional records bringing the total known flora of the island to 208 species are indicated by dots on distribution maps. The sources of these records and the locations of voucher specimens are not listed, however. The majority of the new records are undoubtedly based on specimens collected by Otto William Geist in the late 1930s, but some other collections may be included. Some of the new records also stem from new identification of older material and from

new interpretations of the taxonomy of some of the species represented.

Sixty-six species not known to Hultén (1941-1950) to occur on Saint Lawrence Island are represented in my collections. A list of these species is given in Table 1. Thirteen of these species are represented by Hultén (1968) as having been collected from the island, but the reports are not substantiated. These species are denoted by an asterisk in Table 1.

About half of the species listed in Table 1 are confined to a few protected localities in the southern part of the island. This is particularly true of the aquatic and semi-aquatic species. About 15 species, otherwise unknown on Saint Lawrence, were found along about two miles of river bank in the south central portion of the island.

Table 1. Additions to the known flora of Saint Lawrence Island

Lycopodium clavatum L. ssp. *monostachyon* (Grev. and Hook.) Sel.
Lycopodium alpinum L.
Equisetum scirpoides Michx.
Equisetum palustre L.
Cystopteris fragilis (L.) Bernh. (subspecies indet.)
Dryopteris fragrans (L.) Schott.
Sparganium hyperboreum Laest.
Potamogeton perfoliatus L. ssp. *Richardsonii* (Bennett) Hult.
Potamogeton subsibiricus Hagstr.
Potamogeton vaginatus Turcz.
Triglochin palustris L.
Calamagrostis neglecta (Ehrh.) Gaertn.
Poa alpigena (E. Fries) Lindm.
Festuca altaica Trin.
Eriophorum Scheuchzeri Hoppe var. *Scheuchzeri*
Eriophorum vaginatum L. ssp. *vaginatum*
Kobresia simpliciuscula (Wahlenb.) Mack.

Carex Jacobi-peteri Hult.
Carex pyrenaica Wahlenb. ssp. *micropoda* (C. A. Mey.) Hult.
Carex stylosa C. A. Mey.
Carex livida (Wahlenb.) Willd.
Juncus sp. (aff. *J. Fauriensis* Buch.)
Luzula multiflora (Retz.) Lej. ssp. *multiflora*
Luzula arctica Blytt
Veratrum album L. ssp. *oxysepalum* (Turcz.) Hult.
Rumex graminifolius Lamb.
Polygonum Bistorta L. ssp. *plumosum* (Small) Hult.*
Claytonia arctica Adams
Stellaria ciliatosepala Trautv.
Minuartia arctica (Stev.) Aschers. & Graebn.
Minuartia obtusiloba (Rydb.) House*
Melandrium affine (J. Vall.) Hartm.
Delphinium brachycentrum Ledeb.*
Ranunculus aquatilis L. (subspecies indet.)
Ranunculus Gmelini DC. ssp. *Gmelini*
Ranunculus pedatifidus J.E. Sm. ssp. *affinis* (R. Br.) Hult.
Ranunculus reptans L.
Cardamine microphylla Adams*
Draba macrocarpa Adams
Draba borealis DC.*
Draba nivalis Liljebl.
Draba alpina L.
Draba hirta L.
Braya humilis (C. A. Mey.) Robins. (ssp. indet.)
Saxifraga oppositifolia L. ssp. *oppositifolia**
Rubus arcticus L.*
Potentilla Egedei Wormsk. var. *Egedei**
Potentilla elegans Cham. and Schlecht.
Potentilla uniflora Ledeb.*
Hedysarum alpinum L. ssp. *americanum* (Michx.) Fedtsch.
Callitriche verna L.
Epilobium anagallidifolium Lam.
Epilobium angustifolium L.
Epilobium palustre L.

Viola biflora L.*
Ligusticum mutellinoides (Crantz) Willar*
Phyllodoce caerulea (L.) Bab.*
Vaccinium uliginosum L.
Primula nivalis Pall.
Trientalis europaea L. ssp. *arctica* (Fisch.) Hult.
Gentiana auriculata Pall.
Eritrichium aretioides (Cham.) DC.
Galium Brandegei Gray
Campanula lasiocarpa Cham. ssp. *lasiocarpa*
Campanula uniflora L.
Aster sibiricus L.

Species marked with an asterisk are treated as members of the Saint Lawrence Island Flora by Hultén (1968), but no substantiation is given.

The following records are of particular interest.

Carex Jacobi-Peteri was previously known only from the type location at Cape Prince of Wales (Hultén, 1968). Although not common on Saint Lawrence, this species was found at several locations.

Carex livida from Saint Lawrence represents a range extension of over 500 miles, the nearest previously known station being in central Alaska (Hultén, 1968). The Saint Lawrence record is also apparently the first of this species from well within the true arctic.

The specimens treated as **Juncus** sp. might be considered either as depauperate specimens of *J. Fauriensis* or as an undescribed species. Only a single small station was found. As far as I can discover, *J. Fauriensis* has not been recorded from Alaska.

Gentiana auriculata has apparently been recorded only once before in Alaska, from Attu Island.

Two infraspecific taxa not included by Hultén (1968) in the flora of Saint Lawrence Island are represented in my collections. These are: *Deschampsia caespitosa* (L.) Beauv. var. **glauca** (Hartm.) Sam. and *Pedicularis sudetica* Willd. ssp. **albolabiata** Hult.

Hultén (1941-1950) lists a number of species as being

of somewhat doubtful occurrence on Saint Lawrence Island. In some cases the records are old and the specimens are no longer available, while in other cases the proveniance of the specimens is in some doubt. In the course of my work, I was able to substantiate a number of old or questionable records. Table 2 lists species which are represented in my collections from Saint Lawrence Island, and whose occurrence on the island might previously have been considered somewhat questionable.

A few species which have been reported from Saint Lawrence should be excluded from the flora of the island until their occurrance there can be substantiated by voucher specimens. Some of these situations are the result of specimens being incorrectly labeled as to collection location, while others result from confusion of the taxonomy of such difficult groups as *Carex*, *Draba*, and *Potentilla*. In either case, one can hardly discredit the record without presenting a detailed discussion of each individual case, which is outside the scope of this paper. Let it suffice to say that some 20 to 30 species which have at one time or another been recorded as occurring on Saint Lawrence should be excluded from the flora of the island until their occurrence there can be substantiated. In most of these cases, I have made intensive searches for the species in question at the location from which they were supposedly recorded, and have failed to find them. The species to be excluded from the Saint Lawrence flora will be discussed in a forthcoming paper.

A similar situation exists with respect to some infraspecific taxa. Hultén (1968) claims that 16 of the species known to occur on Saint Lawrence are represented there by two infraspecific taxa, while two species, *Rubus arcticus* and *Senecio atropurpureus* (Ledeb.) Fedtsch. are supposedly represented by three infraspecific taxa apiece.

My field work leads me to believe that there are very few cases in which two good taxa can be distinguished within a single species on Saint Lawrence Island. The discontinuities which appear to exist are usually the result

Table 2. Species collected on Saint Lawrence whose occurrence was previously substantiated only by old or questionable records.

Hierochloe pauciflora R. Br.
Eriophorum callitrix Cham.
Carex subspathacea Wormsk.
Carex Ramenskii Kom.
Carex nesophila Holm
Carex rariflora (Wahlenb.) J. E. Small
Carex misandra R. Br.
Betula nana L. ssp. *exilis* (Sukatsch.) Hult.
Ranunculus Turneri Greene
Saxifraga spicata D. Don
Pyrola grandiflora Radius
Andromeda polifolia L.
Linnaea borealis L.
Artemisia globularia Cham. ex Besser

of insufficient collecting. For example, *Rubus arcticus* apparently reproduces mainly by vegetative means on Saint Lawrence, with the result that the plant usually occurs as discrete colonies, most of which can probably be considered to consist of a single individual. Nevertheless, the range of morphological variation within a single colony is often so great that three separate subspecies could be distinguished using the key given by Hultén (1968).

Under a fairly conservative taxonomic treatment, it appears that the known vascular flora of Saint Lawrence Island consists of about 240 species. Probably no more than 10 of these species are represented by two or more infraspecific taxa.

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TRIPHORA TRIANTHOPHORA (SW.) RYDB. IN MAINE

A new station for this orchid was found in Stow, Oxford County on August 24, 1969. At the present time this is the only known existing occurrence in Maine. Seymour (Flora of New England 1969) does not record it for the state, although it was reported by Jean Wallace ("The Orchids of Maine", University of Maine Bulletin LIII No. 12: 1951) as growing in the Town of Raymond, Cumberland County in 1915. Two records of the species in Maine are given in Miss Wallace's study, the earlier of which is an article entitled "*Pogonia pendula* in Maine" by LeRoy Harvey (Rhodora II: 211-212, 1900). The station at Stow consists of many individuals growing in small groups on a wooded hillside.

In lieu of specimens, photographs in color taken at the station have been deposited at the Herbaria of the University of New Hampshire and the New England Botanical Club.

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FLORISTIC COMPARISON OF THREE BIRD ISLANDS IN THE GULF OF MAINE*

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The influence of birds on the flora of islands is of major interest to biogeographers. Birds are reported to carry propagules for great distances. Cruden (1966) discussing the findings of Darwin, Kerner, Guppy and Willis states, "on the basis of numerous examples which these observers give, there is little doubt that birds act as dispersal agents". There is, thus, some reason to suppose that islands far from land may become populated to a considerable degree by plants whose reproductive structures were transported by birds. Certain islands also support enormous concentrations of sea birds which react with their limited environment in many ways to facilitate or inhibit plant growth. By carefully documenting the flora of three bird islands in the Gulf of Maine, we hope to cast some light on the matter of dispersal of plants to bird islands and on the selective effects birds have on the flora. The three islands to be compared are Machias Seal Island off the coast of Eastern Maine, Matinicus Rock offshore of Matinicus Island in the Gulf of Maine, and Gull Rock, one of the Wolf Islands in New Brunswick in the Bay of Fundy.

Some years ago we published an account of the vascular plants of Machias Seal Island (1962) emphasizing the instability of the flora as indicated by changes in the kinds and abundance of plants recorded at three different times, 1947-48 by Hawksley, 1960 by Pike, and again in 1962 by Pike and two experienced assistants.

So far as we can determine the literature on the plants of bird islands in Northeastern America is sparse or else

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buried in the ornithological literature. One paper which relates somewhat to our work is by Smith and Schofield (1959). They observed and collected the vascular flora of Ciboux and Hertford Islands off the east coast of Cape Breton in Victoria County, Nova Scotia. Hertford Island of 27 acres lies about one and one-half miles east of the mainland of Cape Breton while Ciboux of 35 acres is out another half mile. These two islands are much closer to the mainland than the three bird islands discussed in this paper and presumably have become invaded by heavy bird populations in recent time, indicated in part by the presence of several living woody species of trees and shrubs and by evidences of earlier forest conditions. The fact that woody species were diminishing on these islands is in line with our observations.

Considerable work on bird islands has been carried out in Great Britain admirably summarized with many references by Darling and Boyd (1964). North Rona, an island of 300 acres reaching a height of 355 feet and lying some 45 miles from the mainland, resembles our bird islands in some ways. In several visits of botanists no woody species have been recorded and, at each visit, some new species appeared and others were absent. The first botanical record made gave 35 species; on the next visit 4 of these were missing but 12 new ones appeared. Again a few years later 8 of those recorded earlier could not be found but 4 new ones appeared. This fluctuating record is somewhat similar to our findings on Machias Seal Island (1962).

A repeat visit to Machias Seal Island was planned to follow after an interval of several years to discover what further changes might have taken place. The earliest convenient time, when weather and other circumstances allowed, was on August 8, 1967, after a month or more of almost continuous fog. No striking changes were noted in 1967 compared with the 1962 observations and list. It should be kept in mind that the records made by Hawksley in the years 1947 and 1948 reflected, by his own account, the pressure of heavy grazing and much interference with

nature. The establishment of Machias Seal Island as a bird sanctuary with consequent protection of its plant life must have helped to stabilize its vegetation. The few additional species that we found for the first time in 1967 are so indicated in the accompanying list. Some of these probably were overlooked in September 1960 and 1962 because of the exceedingly lush growth of overtopping asters in those years. At the time of our visit in early August 1967, the asters were still in an early stage of growth.

The next logical step involved making a comparison of Machias Seal with other islands having somewhat similar environmental parameters. Matinicus rock, far out to sea south of Rockland, Maine, and several miles farther out than Matinicus Island itself, came immediately to mind. Both Machias Seal and Matinicus Rock which are of approximately the same size, ten to twelve acres, have had a long recorded history of occupancy by puffins, razor-billed auks and arctic terns. Both also have supported lighthouses but, being treacherous of access, have repelled human visitors except students of birds. In early 1966 we had received permission from Dr. & Mrs. Buckheister and the National Audubon Society to visit Matinicus Rock at a time of year when there would be no disturbance to nesting birds, but it was not until September 2, 1967, that we succeeded in getting there. Storms in 1966 and almost continuous fog in the summer of 1967 made it more difficult to reach Matinicus Rock than any of the many other islands we have visited during our eight years of botanizing in the Bay of Fundy and Gulf of Maine. Our visit in early September proved to be very difficult; strong, cold winds and rough water, as well as some fog and rain, permitted us only about one and one-half hours ashore to make collections, record observations, and make a photographic reconnaissance.

Matinicus Rock is aptly named, the island is chiefly exposed granite and, unlike Machias Seal Island which has extensive "meadows" of asters, umbellifers, docks, grasses, sedges, sorrel, etc., the "Rock" has only continuous ledge with many interrupted limited patches of vegetation. Both

islands have some pools, those on Matinicus Rock being much more numerous and thus accounting perhaps for the presence there of two species of *Scirpus*. On the other hand, *Callitriche*, an ideal pool inhabitant, was present on Machias Seal Island but absent from the "Rock" indicating that, after all, chance must play an important role in the migration of plants to these islands. Certainly such pools of varied extent, some of them toward the highest parts of Matinicus Rock, would be excellent habitats for many kinds of aquatic or paludal plants.

During our brief stay, it was possible to visit all obvious habitats and nearly all of the separate patches of vegetation. A total of 64 species was collected, this being a larger number than was taken at any one visit to Machias Seal Island. Considering the much larger area in vegetation on Machias Seal, we could accept this list as being reasonably complete for the year 1967 but, knowing the inadequacies of single collecting visits made under even the best of conditions, we must be frank to state that undoubtedly there are some species on Matinicus Rock yet to be discovered.

Gull Rock is different in several respects from the other two bird islands. It lies closer to other bits of land, being less than a half mile from the nearest of the other Wolves; it is much smaller and rises more precipitately on all sides from the sea thus affording less opportunity for supralittoral plants to grow and it supports gull populations instead of tern-auk-puffin societies of Machias Seal and Matinicus Rock. However, it shares certain characteristic features with the others. All three are far from the mainland, Machias Seal 11 miles, Matinicus Rock 19 miles, and Gull Rock 8 miles. There is, at the present time, little direct human interference with vegetation on any one of the three and no species of woody plant is found on any of them.

While there is no close positive correlation in general of size of island and diversity of habitats, the islands under consideration do show such a correlation, Gull Rock, the smallest, having certainly fewer kinds of niches for vascu-

lar plants. This presumably is reflected in the presence of only 34 species of vascular plants there.

The influence of birds on these island floras is shown in many ways. All woody plants are excluded, embracing entire families or major taxonomic groupings, eg. Gymnospermae, Salicaceae, Myricaceae, Corylaceae, Saxifragaceae, Empetraceae, Aquifoliaceae, Aceraceae, Ericaceae and Caprifoliaceae. Other major groups absent are Equisetaceae, Lycopodiaceae and Polypodiaceae, the only fern noted being the cinnamon fern, *Osmunda cinnamomea* on one island. No Orchidaceae were present while the following families were each represented sparsely on one island only by a single species: Liliaceae, Violaceae, Onagraceae and Labiatae. The above groups are all well represented on non-bird islands in the Gulf of Maine, sometimes in the immediate vicinity as in the Wolf Island group. It is evidently the environment created by the birds en masse that inhibits the growth of these species.

The Wolf Islands other than Gull Rock are forested except for limited clearings and bird lawns although some forested portions in areas adjacent to bird lawns have been invaded by birds. Where concentrations of gulls are heavy, the conifers in particular are killed, but there seems to be stimulation of growth in many other groups. For example, in these situations we have noted an increase in growth in *Rubus idaeus*, *Ribes lacustre*, *R. hirtellum*, *R. glandulosum*, several species of *Solidago* and *Aster*, *Achillea Millefolium*, *Iris versicolor*, *Ligusticum scothicum*, *Conioselinum chinense*, *Streptopus* spp. *Dryopteris spinulosa* var. *americana* and some other species. It seemed to us that the mere release of these plants from the overstory of conifers would hardly have accounted for such lush development. Apparently up to a high level of fertility, many woody plants and various other kinds as well are stimulated but beyond this level toxicity results. It might also happen that direct contact of plants and birds in such cases serves to destroy the plants. Experimental work is needed to show in what way

the environment inhibits the germination and or subsequent development of many kinds of plants.

The conclusion seems warranted that the environment provided by nesting birds on small islands in the Gulf of Maine serve initially to screen out and eliminate a considerable percentage of potential migrant plants or of plants already present and to select the majority of its species from relatively few taxonomic groups.

It follows that certain families of plants will be strongly represented; the Gramineae account for 16 out of the total of 114 species on the three islands. The Polygonaceae include 8, Caryophyllaceae 8, Leguminosae 7 and the Compositae 19. Thus, these 5 families comprise a bit over 50% of the total bird island flora. This contrasts markedly with the same families comprising 28.5% of the total Wolf Island vascular flora.

Three categories may be made of the bird island plants, first the species that occur on all three islands, second those on two and finally those found only on one. Twenty-one species are common to all the islands. These are generally of common occurrence in the region with no particular adaptation for the bird islands as is shown by the presence of all of them in considerable abundance on the non bird island members of the Wolf Island group as well as their frequency of occurrence elsewhere in the coastal areas nearby. This group of species is well adapted to the climatic and edaphic conditions of the region and also posseses effective means of dispersal.

The list of species that are present on any two of the three bird islands but are lacking from the third includes only 18 species. Thirteen species are shared by Machias Seal Island and Matinicus Rock and are absent from Gull Rock. Two of this group, *Juncus bufonius* and *Plantago juncoides* are of very general distribution in the area and their absence from Gull Rock or at least the fact that we didn't find them there is attributable to the fact that Gull Rock has a very abrupt rocky shore providing few or no suitable habitats for either species. The other 11 species

of the group absent from Gull Rock are in general somewhat less widely distributed on the other Wolf Islands than those species of the first group and their absence perhaps may be accounted for also by the scarcity of suitable habitats. Four species are found on Machias Seal and Gull Rock but are absent from Matinicus Rock while only one species, *Lathyrus japonicus*, occurs on Gull Rock and Matinicus Rock only.

The remaining 75 species or nearly 66% of the bird island flora are present on only one of the three bird islands. Many of these casual species are weeds which in all probability were brought to the islands by man during his occupation of Machias Seal and Matinicus Rock where the majority of these are found. Many weeds have propagules which undobutedly may be carried far by air currents, water or birds. It is to be noted however that *Ambrosia artemisiifolia* which is absent from two of the bird islands, being found only on Matinicus Rock, is absent also from all of the Wolf Island group. Several years ago we paid a brief visit to another bird island known as White Horse Island, a Cormorant rookery and the nearest land to the Wolves. One of the dominant weeds there was *Ambrosia artemisiifolia* growing with huge nettles (*Urtica* sp.) making a most disagreeable tangle virtually covering the entire island. Both species are absent from Gull Rock though we have observed nettles on three of the other Wolf Islands. Human visitors on White Horse Island must be more frequent than on Gull Rock since the former is only a mile or two away from Campobello Island and the mainland of New Brunswick. Also it is much more likely that bird visitors from the settled islands and mainland could have introduced propagules more often on White Horse Island than on the Wolves because of the shorter distance to travel.

Several species seem to be of chiefly fortuitous occurrence on the three bird islands such as *Callitriche heterophylla*, *Arenaria lateriflora* and *Galium tinctorium* on Machias Seal Island and *Ranunculus Cymbalaria*, *Convolvulus sepium* and *Mertensia maritima* on Matinicus Rock. The

habitats for these native species as well as for most of the introduced weeds would seem to be about equally favorable on both Machias Seal and Matinicus Rock.

It is evident also that many of the records of plants found on only one island relate in some way to the proximity of that island to other land masses nearby, for example Gull Rock to the other Wolf Islands, Machias Seal to Grand Manan and the Coast of Maine and Matinicus Rock to Monhegan Island and Matinicus Island.

The conclusion seems tenable that these bird islands, following the initial screening out or elimination of many kinds of plants including all woody plants, become populated to a great extent by introduced weeds or by those native species that occur abundantly on the nearest bodies of land. This is not to rule out the probability that part of the bird island flora is residual, having occupied these islands from early post glacial times or at least from some time previous to their domination by birds. It would appear that man has introduced many species of plants to suitable habitats on these islands. The evidence seems to show also that occasionally as with *Callitriche* on Machias Seal Island, birds may well be agents of wide dispersal. It should be kept in mind that puffins, razor-billed auks and arctic terns, which spend their time at sea except when nesting, are not likely candidates for effective transport of plant propagules. Herring gulls on the other hand are in part markedly terrestrial and theoretically should be effective as agents of dispersal. The failure to find strong correlation of floras on the several islands and the frequent absence of potentially adapted species such as *Ambrosia artemisiifolia* which often are abundant a few miles or less away from an island, suggest to us that dispersal over miles of open ocean to bird islands is not frequently accomplished. Our study indicates that the screening effect of bird populations on bird island floras is more apparent than their transport of propagules.

Herbarium specimens from the three bird islands dis-

cussed are deposited in the Herbarium of the University of New Hampshire (NHA).

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COMPARATIVE LIST OF FLORAS ON THREE BIRD ISLANDS

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
1. *Osmunda cinnamomea* L.	X		
2. *Festuca rubra* L. var. *rubra*	X	X	X
3. *Puccinellia laurentiana* Fern. & Weath.			X
4. *P. paupercula* (Holm) Fern. & Weath. var. *alaskana* (Scribn. & Merr.) Fern. & Weath.	X	X	X
5. *Poa annua* L.	X	X	X
6. *P. compressa* L.			X
7. *P. pratensis* L.	X (1967)		
8. *P. palustris* L.	X (1967)		
9. *Agropyron repens* (L.) Beauv.	X	X	X
10. *Hordeum jubatum* L.		X	
11. *Elymus arenarius* L. var. *villosus* Mey.	X	X	X
12. *Elymus virginicus* L.		X	
13. *Deschampsia flexuosa* (L.) Trin.			X
14. *Calamagrostis canadensis* (Michx.) Nutt.	X		X
15. *Agrostis alba* L. var. *alba*	X		
A. alba var. *palustris* (Huds.) Pers.	X	X	X
16. *Phleum pratense* L.	X	X	
17. *Anthoxanthum odoratum* L.	X (1967)		
18. *Scripus validus* Vahl. var. *creber* Fern.		X	
19. *Scirpus paludosus* Nels. var. *atlanticus* Fern.		X	
20. *Carex canescens* L. var. *canescens*	X		

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
21. *C. brunnescens* (Pers). Poir. var. *sphaerostachya* (Tuckerm.) Kukenth.	X (1967)		
22. *C. scoparia* Schkuhr	X		
23. *C. silicea* Olney	X		
24. *C. hormathodes* Fern.	X	X	
25. *C. paleacea* Wahlenb.	X		
26. *C. crinita* Lam. var. *crinita*			X
27. *Juncus bufonius* L.	X	X	
J. bufonius var. *halophilus* Buchenau & Fern.	X		
28. *Smilacina stellata* (L.) Desf.			X
29. *Sisyrinchium montanum* Greene	X		
30. *Iris versicolor* L.	X	X	X
31. *Urtica gracilis* Ait.		X	
32. *U. viridis* Rydb.	X		
33. *Rumex pallidus* Bigel.	X	X	
34. *Rumex domesticus* Hartm.		X	
35. *R. orbiculatus* Gray	X		
36. *R. crispus* L.	X	X	
37. *R. Acetosella* L.	X	X	X
38. *Polygonum aviculare* L.	X	X	X
39. *P. Persicaria* L.		X	
40. *P. Convolvulus* L.		X	
41. *Chenopodium album* L.		X	
42. *Atriplex patula* L.	X	X	X
43. *A. glabriuscula* Edmondst.	X	X	

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
44. *Suaeda americana* (Pers.) Fern		X	
45. *S. Richii* Fern.		X	
46. *Spergularia marina* (L.) Griseb. var. *leiosperma* (Kindb.) Gurke	X	X	X
47. *S. canadensis* (Pers.) Don		X	
48. *Sagina procumbens* L.	X (1967)	X	
49. *Arenaria lateriflora* L.	X		
50. *Stellaria media* (L.) Cyrillo	X	X	X
51. *S. graminea* L.	X		
52. *Cerastium arvense* L.		X	
53. *C. vulgatum* L.	X	X	X
54. *Ranunculus Cymbalaria* Pursh		X	
55. *R. repens* L. var. *villosus* Lamotte	X		
56. *R. acris* L.	X		
57. *Thalictrum polygamum* Muhl.	X		X
58. *Capsella Bursa-pastoris* (L.) Medic.	X		
59. *Cakile edentula* (Bigel.) Hook.		X	
60. *Raphanus Raphanistrum* L.		X	
61. *Brassica juncea* (L.) Coss.		X	
62. *Sedum Rosea* (L.) Scop.	X	X	X
63. *Potentilla norvegica* L.	X	X	X
64. *P. anserina* L.	X	X	
65. *P. Egedei* Wormsk. var. *groenlandica* (Tratt.) Polunin	X		
66. *Rubus idaeus* L. var. *strigosus* (Michx.) Maxim.			X

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
67. *Trifolium pratense* L.	X		
68. *T. repens* L.	X	X	X
69. *T. hybridum* L.	X		
70. *Vicia angustifolia* Reichard	X		
71. *V. Cracca* L.	X		
72. *Lathyrus japonicus* L.		X	X
73. *L. palustris* L.	X		
74. *Callitriche heterophylla* Pursh	X		
75. *Impatiens capensis* Meerb.	X	X	X
76. *Viola Mackloskii* Lloyd subsp. *pallens* (Banks) Baker	X		
77. *Epilobium glandulosum* Lehm. var. *adenocaulon* (Haussk.) Fern.		X	
78. *Carum carvi* L.	X		
79. *Ligusticum scothicum* L.	X	X	X
80. *Coelopleurum lucidum* (L.) Fern.	X	X	X
81. *Glaux maritima* L.	Seen (1967)		
82. *Convolvulus sepium* L. var. *sepium*		X	
83. *Mertensia maritima* (L.) S.F. Gray		X	
84. *Lycopus uniflorus* Michx.	X		
85. *Solanum Dulcamara* L.		X	
86. *S. nigrum* L.		X	
87. *Euphrasia Randii* Robins.	X		
88. *E. canadensis* Townsend	X		
89. *E. americana* Wettst.	X		

	MACHIAS SEAL ISLAND	MATINICUS ROCK	GULL ROCK
90. *Rhinanthus Crista-galli* L.	X		
91. *Plantago major* L.	X	X	
92. *P. juncoides* Lam. var. *decipiens* (Barneoud) Fern.	X	X	
93. *P. oliganthos* R.&S.		X	
94. *Galium Aparine* L.		X	
95. *G. tinctorium* L.	X		
96. *Solidago rugosa* Ait. var. *villosa* (Pursh) Fern.			X
97. *S. sempervirens* L.		X	
98. *Aster foliaceus* L. (Complex)	X	X	X
99. *A. novi-belgii* L.			X
100. *A. johannensis* Fern.	X		
101. *A. umbellatus* Mill.	X		X
102. *Gnaphalium uliginosum* L.	X		
103. *Ambrosia artemisiifolia* L.		X	
104. *Bidens frondosa* L.		X	
105. *Achillea borealis* Bong.	X		X
106. *A. lanulosa* Nutt.	X	X	
107. *A. Millefolium* L.		X	
108. *Matricaria matricarioides* (Less.) Porter	X	X	X
109. *Cirsium arvense* (L.) Scop.	X	X	
110. *Leontodon autumnalis* L.	X		
111. *Taraxacum erythrospermum* Andrz.	X		
112. *T. officinale* Weber	X	X	
113. *Sonchus oleraceus* L.		X	
114. *S. asper* (L.) Hill	X		

A PRELIMINARY INVESTIGATION OF THE BENTHONIC MARINE ALGAE OF THE CHESAPEAKE BAY REGION

ARTHUR C. MATHIESON AND STEPHEN W. FULLER[1]

Few studies have been conducted upon the benthonic marine algae of Chesapeake Bay. Zaneveld (1966a) described the Cyanophyta flora of the area (i.e. between Cape May, New Jersey, and Cape Hatteras, North Carolina), but no systematic account of the other divisions is recorded. Zaneveld and Barnes (1965) described the reproductive periodicity of several species of seaweeds from the lower Chesapeake Bay. Wulff et al. (1968) have described the summer marine algae from a jetty on the open coast at Ocean City, Maryland.

In the present paper we summarize the species found at 63 stations on the Chesapeake Bay and the Patuxent River (see Fig. 1 and Tables I-III for details of locations). All collections were made by the junior author in connection with a summer (1968) marine botany course given at the Chesapeake Biological Laboratory of the University of Maryland.

The Bay is characterized by brackish waters and a lack of stable substrate. At most stations the bottom was sandy, but muddy areas were also evident. Seaweeds were attached to scattered boulders, pebbles, shells, pilings, cement blocks or other solid substrates. The surface water salinities ranged from 18.1 o/oo in the lower Bay to 3.4 o/oo in the upper Bay, and to 1.9 o/oo in the upper Patuxent River. The surface water temperatures at the same locations ranged from 24.8 to 30°C — most readings being near 27°C. The greatest temperature difference between the surface and bottom levels of water (35 feet in depth) was 2.5°C.

Several shore collections were made at the mouth of the Patuxent River from June 26 to August 7, 1968, (Fig. 1

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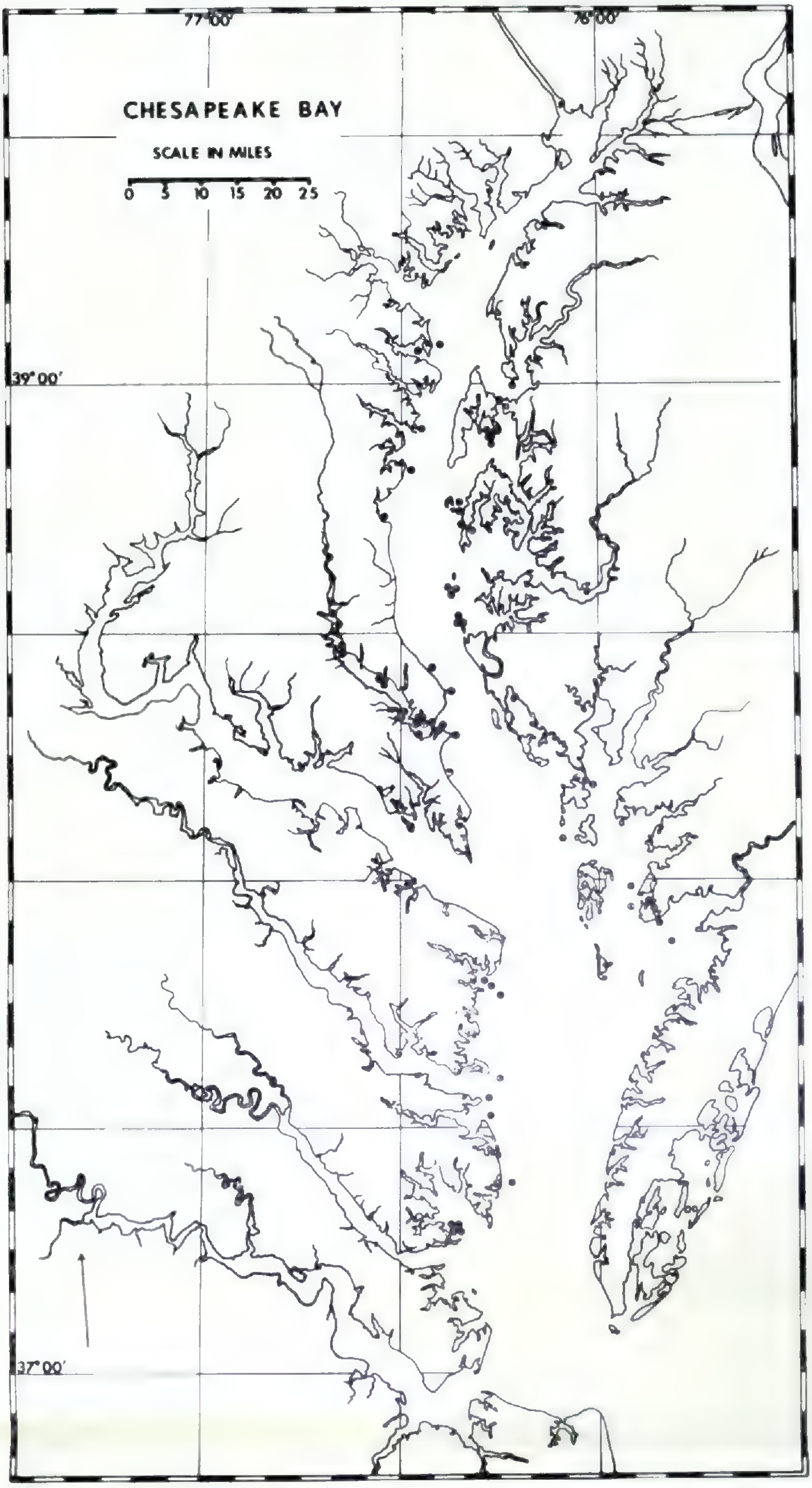

Fig. 1. Chesapeake Bay and Patuxent River Stations.

and Table I). Offshore collections were made in the Bay on July 1, 8, 19 and 25, 1968 (Table II) and the Patuxent River on August 7, 1968 (Table III). The offshore collections were made aboard the motor vessel Orion or the Bluefish. Samples were obtained with a steel frame trawl or with oyster tongs. Herbarium voucher specimens were made for all conspicuous species at each station. A complete set of specimens is deposited in the Herbarium of the University of Maryland, while a partial set has been deposited in the Algal Herbarium of the University of New Hampshire. The nomenclature of the recent British Checklist (Parke and Dixon, 1964) has been applied in most cases.

List of Species

CHLOROPHYTA

Cladophorales

*__Cladophora flexuosa__ (O. F. Müller) Harvey
(Equals *C. sericea* (Hudson) Kützing sensu van den Hoek)
Dredged in 5 feet of water at station F-5.

*, †__Cladophora flexuosa__ (Dillwyn) Harvey f. __densa__ Collins
Found floating at station A-7. Previously recorded from Rhode Island (Collins, 1902).

*, †__Cladophora gracilis__ (Griffiths *ex* Harvey in Mackay) Kützing
Equals *C. sericea* (Hudson) Kützing sensu van den Hoek)
Attached to rocks at stations A-9 and A-10. Dredged with *Zostera marina* at station B-5. Previously recorded from New Jersey to Newfoundland (see Taylor, 1957, for references).

*__Rhizoclonium riparium__ (Roth) Harvey
Found once attached to pier pilings at station A-1.

Ulotrichales

*__Enteromorpha clathrata__ (Roth) J. Agardh
Entangled amongst *Zostera marina* at station A-3.

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*Indicates a new record for Maryland.
†Indicates a southern extension of range on the Northeast Coast of North America.

Enteromorpha intestinalis (L.) Link
Found unattached at stations A-3 to A-7, A-9, A-10, B-9, C-12, E-3, E-4, F-2, and F-5. Found attached (rocks, shells or logs) at stations A-3, A-6 and A-7.
Enteromorpha minima Nageli
(Equals *Blidingia minima* (Nageli *ex* Kützing) Kylin)
On pier pilings at station A-4 and on rocks at station A-6.
Enteromorpha prolifera (O. F. Müller) J. Agardh
Found once on pier pilings at station E-3.
*__Monostroma oxyspermum__ (Kützing) Doty
Found once on a rock wall at station A-6.
*__Pseudendoclonium marinum__ (Reinke) Aleem *et* Schulz
(Equals *Protoderma marinum* Reinke in Taylor, 1957)
Found on rocks at stations A-7 and A-8.
*, †__Ulothrix flacca__ (Dillwyn) Thuret in Le Jolis
Found on pier pilings at stations A-1 and A-4 and on rocks at station A-7. Previously recorded from New Jersey to Baffin Island (see Taylor, 1957, for references).
Ulva lactuca L.
Found unattached and free-floating at stations A-3, A-4, A-6, A-8, A-10, B-1, B-5, B-9, C-1, C-4, C-5, C-6, C-8, C-12, E-1, E-2 and E-3. Attached to rocks or shells at stations A-3 and A-6.

RHODOPHYTA

Nemalionales

*__Acrochaetium flexuosum__ Vickers
Found as an epiphyte on *Zostera marina* at station F-5.
*, †__Trailliella intricata__ (J. Agardh) Batters
Common as an epiphyte on *Ceramium strictum*, *Polysiphonia harveyi*, *Zostera marina* and other species. Present at stations B-1, B-2, B-3, B-5, B-6, and B-10. According to Harder (1948) *T. intricata* is the tetrasporophyte generation of *Asparagopsis hamifera*. *T. intricata* was previously recorded from Long Island to Newfoundland (see Taylor, 1957, for references).

Rhodymeniales

Champia parvula (C. Agardh) Harvey
Dredged at stations B-3, B-4, B-5, B-6 and B-8.

Gigartinales

Agardhiella tenera (J. Ag.) Schmitz
Dredged at station D-3.

Gracilaria verrucosa (Hudson) Papenfuss
Dredged or in drift at stations A-8, A-10, B-1, B-2, B-3, B-4, B-6, B-8, B-11, C-4, C-7, C-8, C-12, D-1, D-3, E-1, E-2, and E-4.

Ceramiales

Ceramium rubrum (Hudson) C. Agardh
Epiphyte on *Gracilaria verrucosa*, *Zostera marina* and other plants — only occasionally unattached. Present at stations A-3, A-6, A-10, B-1, B-2, B-3, B-4, B-5, B-8, B-9, B-11, C-4, C-7, C-8, C-12, D-1, E-3, E-4, and F-5.

Ceramium strictum Harvey
A common epiphyte on *Gracilaria verrucosa*, *Zostera marina* and *Ceramium rubrum*. Present at stations A-3, A-6, A-7, A-10, B-1, B-2, B-3, B-4, B-5, B-6, B-8, B-9, B-11, C-6, C-8, C-12, D-1, F-2, and F-5.

Dasya pedicellata (C. Agardh) C. Agardh
Found unattached at stations A-10, C-3, C-4, C-5, C-6, E-1 and F-2.

Polysiphonia harveyi Bailey
Found unattached at stations A-6, A-7, A-10, B-1, B-5, B-8, B-9, C-4, C-5, C-6, C-7, C-8, C-12, D-1, E-1, E-2 and E-3. Epiphytic on *Zostera marina* and other aquatic flowering plants at stations E-4, F-2 and F-5.

Spyridia filamentosa (Wulfen) Harvey in Hooker
Found unattached at stations B-2 to B-7, B-10, B-11 and D-1. Found as an epiphyte on *Zostera marina* at station B-1 and on *Ceramium strictum* at station D-1.

PHAEOPHYTA

Sphacelariales

*__Sphacelaria fusca__ (Hudson) C. Agardh
Found once epiphytic on *Zostera marina* at station F-5; mixed with *Acrochaetium flexuosum* and *Enteromorpha intestinalis*.

Of the 23 taxa of marine algae found in the Chesapeake Bay and Patuxent River, 11 are new records for the state

of Maryland and 4 are southern extensions of known distributional ranges. Only one species of brown algae was recorded by us, although a few others are known for the lower Bay (Zaneveld and Barnes, 1965). The paucity of vegetation in the area is primarily related to low salinities and a lack of stable substrate. The biomass and diversity of species in the Chesapeake Bay is much less than in estuarine areas of New England (e.g. Great Bay, New Hampshire, or Penobscot Bay, Maine), where fucoid and green algae dominate. More detailed seasonal investigations in the Chesapeake Bay will no doubt reveal additional species which are known for the vicinity (Wulff et al., 1968; Wulff and Webb, 1969; Zaneveld, 1965, 1966b).

We would like to express our gratitude to the faculty, staff and students at the Chesapeake Biological Laboratory of the University of Maryland, who assisted the junior author in collecting specimens and hydrographic data. Particular appreciation is extended to Dr. R. W. Krauss, who directed the summer (1968) marine botany course, and to Miss Jean Snider who supplied temperature and salinity information for the Patuxent River stations.

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Table I. Shore Stations

Station #	Location
	June 26 to August 7, 1968
A-1	Pilings at Chesapeake Biological Laboratory boathouse
A-2	Pilings at Chesapeake Biological Laboratory pier
A-3	Beach on s. shore Patuxent R., just w. of entrance to Naval Station seaplane harbour
A-4	Drum Point, mouth of Patuxent River
A-5	#5 beacon, mouth of Patuxent River
A-6	Rock retaining wall on Naval Base property, s. shore of Patuxent River
A-7	Abandoned Cedar Point Light House
A-8	Beach midway between Cedar Pt. and Point No Point — south of Patuxent River mouth
A-9	Cove Point, just north of Patuxent mouth
A-10	Beach north of Cove Point

Table II Bay Stations

Station #	Location	Salinity 0/00 Sfc	Salinity 0/00 Bottom	Temperature °C Sfc	Temperature °C Bottom	Depth of Bottom
	July 1, 1968					
B-1	Holland Str. off So. Marsh Is., near #2 beacon	11.5	12.0	28	27	10′
B-2	Midway between #9 beacon and James Is. Lt. off Chrisfield	15.0	15.1	27.3	26.0	85′
B-3	Great Rock Oyster Bar, 3000 yds. so. of James Is. Lt.	15.2	15.3	26.7	26.5	20′
B-4	Little Annemessex River at mouth of Battle Creek	16.4	16.4	28.6	27.6	12′
B-5	Midchannel in Broad Creek (connects Little Annemessex R. and Pocomoke Sound)	16.8		28.4		6′
B-6	Pocomoke Sound, off Broad Creek	16.1	16.1	29.0	28.8	12′
B-7	Pocomoke Sound, Va., near red nun #6	16.7	16.5	27.6	27.1	
B-8	Shark Fin Shoal, east of Bloodsworth Island	13.0	13.1	27.1	27.6	9′
B-9	1.5 miles east of Bloodsworth Island	13 2	13.2	28	27.9	10′
B-10	Between red nun #4 and Hooper Strait Light	12.6	12.4	28.2	28.3	12′
B-11	Mouth of Patuxent R. near Obstruction Buoy, w. of Drum Pt.	10.4	10.7	27.3	26.3	6′
	July 8, 1968					
C-1	1.25 miles s.w. of red nun #66, 170° off Sharps Is. Lt.	7.6	14.8	25.0	22.7	35′
C-2	1 mi. so. of red nun #66, off Sharps Is. Lt.	8.1	8.8	24.8	24.9	20′
C-3	1300 yds. e. of red nun #66, off Sharps Is. Lt.	8.3	9.1	25.3	25.2	12′
C-4	Between Poplar Is. Narrows Lt. and can #1	7.4	7.9	26.0	25.9	10′
C-5	900 yds. e. of Coaches Island	8.1	8.5	26.0	25.3	10′
C-6	Mouth of Crab Alley Bay, 900 yds. off Parson Is. & 1800 yds. off Bodkin Is.	8.7	8.4	26.5	26.2	6′
C-7	Crab Alley Bay, between can #1 and Bodkin Is.	8.6	8.5	27.4	26.1	6′

Station #	Location	Salinity 0/00 Sfc	Salinity 0/00 Bottom	Temperature °C Sfc	Temperature °C Bottom	Depth of Bottom
C-8, 9, & 10	Three drags successively further s.e. of "C-7"	9.1	8.8			20′
C-11	4400 yds. w.n.w. of James Is., which is just n. of Taylors Is.	8.3	9.5	26.3	25.6	20′
C-12	Channel between James Is. and red nun #2; 3 drags: 10′, 16′, 6′	9.0	9.1	26.8	26.9	6′
	July 19, 1968					
D-1	Mobjack Bay, 2600 yds. n.w. of can #3, 1200 yds. off Guinea Marsh	18.1	18.2	29	28.7	8′
	3 other drags: 1000 yds. off Guinea Marsh					6-7′
	1500 yds. off Guinea Marsh					10′
	2300 yds. off Guinea Marsh					23′
D-2	2700 yds. w. of Wolf Trap Lt., 1900 yds. off shore					8-12′
D-3	Gwynn Is., 300 yds. inshore of #1 beacon					18- 8′
D-4	Just inside Stingray Point Lt.					8′
D-5	1400 yds. w. of Windmill Pt. Lt.					10′
D-6	Just off Dameron Marsh, 1400 yds. w. of #1 beacon					10′
D-7	Fleet Pt. Bar					12′
D-8	Off Dameron Marsh, 1800 yds. off Greater Wicomico R. Lt.			29		12′
	July 25, 1968					
E-1	E. of Knapps Narrows, 500 yds. n.n.e. of beacon	10.1	10.1	28.9	28.8	5-8′
E-2	W. of Knapps Narrows, 300 yds. n. of beacon	10.1	10.2	28.5	28.5	9′
E-3	Kent Narrows, plants found floating & on pilings at Piney Narrows Marina					

Station #	Location	Salinity 0/00 Sfc	Salinity 0/00 Bottom	Temperature °C Sfc	Temperature °C Bottom	Depth of Bottom
E-4	Chester River, 800-1000 yds. off Cedar Pt.	7.5	7.7	29.6	28.5	5′
E-5	400 yds. off Gibson Is.	3.4				10-15′
E-6	Sillery Bay			30	27.5	10′
E-7	Thomas Point Shoals					6-9′
E-8	Cedar Hurst, 2400 yds. offshore					5-6′
E-9	Hering Bay, Parkers Shoal Light	10.8	10.7	28.9	28.7	5′

Table III Patuxent River Stations

Station #	Location	Salinity 0/00 Sfc	Salinity 0/00 Bottom	Temperature °C Sfc	Temperature °C Bottom	Depth of Bottom
	Samples collected August 7; Temperatures and Salinity recorded August 20, 1968					
F-1	Off Hog Pt., mouth of river	13.1	16.9	29.3	26.6	45′
F-2 & F-3	Two drags were taken 250 yds. off Half Pone Pt. T & S recorded midchannel between Half Pone Point and Point Patience	12.6	16.8	29.8	26.3	100′
F-4	200 yds. s. of beacon #16 off Broomes Is.	11.5	11.6	30.3	29.1	50′
F-5	200 yds. w. of Broomes Is.					
F-6	100 yds. e. of can #2 off Sheridan Pt.	10.6	11.4	30.5	29.5	35′
F-7	250 yds. n. of Sheridan Pt.					
F-8	100 yds. s. of red nun #26, off Hallowing Pt.	9.5	10.0	29.2	28.7	50′
F-9	200 yds. off Craney Creek, Hallowing Pt.					
F-10	Pilings at Power Station, Chalk Pt. The T & S were recorded 100 yds. n. of red nun #30	8.1	8.9	30.2	29.5	17′
F-11	100 yds. off Trueman Pt. The T & S were recorded 400 yds. off the Point	5.4	6.3	29.2	29.1	15′
F-12	Overhead power cables midway between Holland Cliff and Cocktown Cr.	1.9	2.2	28.4	28.1	20′ 30′
F-13	Off Lower Marlboro					

ETYMOLOGY OF PSYCHOTRIA IN VIEW OF A NEW USE OF THE GENUS

HOMER V. PINKLEY

During ethnobotanical research among the Kofán Indians of eastern Ecuador, *Psychotria viridis* R. & P. was observed and for the first time, identified as an admixture in the preparation of their hallucinogenic beverage known as *yáje* (6, 7, 8). In the Kofán language, this plant is known as *oprito*, which, interestingly enough, is the name given to the human-like images which these Indians call "the heavenly people" and which they see while under the effect of the narcotic drink. They say that ". . . in order to increase their visions and to make them of longer duration . . ." the leaves and young shoots of the plant are added (1).

Psychotria viridis is a glabrous shrub or small tree growing usually in low land which may be flooded part of the year or quite frequently a short distance from streams or small rivers in the primary forest. The plant is characterized by ". . . stipules large, acuminate, thin, brown, caducous; leaves short-petiolate, obovate or obovate-oblong, acute or short-acuminate at the apex, cuneately attenuate to the base; inflorescence terminal, pedunculate, spicate-paniculate, the lower branches verticillate, the minute flowers sessile in distant glomerules; corolla greenish white; fruit red."(10) The plant has a wide distribution from Central America south to Bolivia.

Because this is the first report of the use of a member of the Rubiaceae as an hallucinogen, I became interested in the etymology of the generic name. One could easily believe that *Psychotria* is derived from the Greek ψυχή (psyche), meaning mind, soul, or breath, but I do not feel this is the case. Linnaeus (4) derived *Psychotria* from Patrick Browne's name *Psychotrophum* (2). Linnaeus took *Psycho-* from *Psychotrophum* and added the nominative ending *tria*. Unfortunately, neither Linnaeus nor Browne state their reason for deriving these names. The following

interpretation, which I believe to be wrong, became the accepted dictionary explanation of the origin of *Psychotria*. Wittstein (11) states, "*Psychotria* L. (Rubiaceae) Zus. aus ψυχη (Seele, Leben) und τρεφειν (ernärhen, erhalen); aus den Samen den Ps. herbacea bereitet man nach P. Browne auf Jamaica ein angenehmes coffeeähnliches Getrank. Linné zog den ursprünglich von Browne gebildeten Namen Psychotrophum zusammen." Furthermore, in agreement with Wittstein, J. K. Small (9) states: "The generic name *Psychotria* is derived from a combination of two Greek words signifying soul-nourishment; the seeds of some species are used in the tropics as a substitute for coffee, hence the name wild coffee." But upon careful study of Browne's statement, "The seeds of all the species are pretty much like those of coffee," I surmised that he was not at all referring to a use of the seed but was rather describing and morphologically comparing the seed (2). After describing his "genera," Browne would often present a brief botanical summary giving an inclusive description of the group. This is what he did in the case of *Psychotria* which was later misinterpreted by Small, Wittstein, and perhaps, even by Linnaeus since the meaning of Browne's word is not fully expressed in the name Linnaeus coined. Before coming to this conclusion, I searched several early sources to see if any similar uses of *Psychotria* had been recorded, but I found none. Moreover, both Dr. Dennis Adams of the University of The West Indies and Mr. George R. Proctor of The Institute of Jamaica, through correspondence, reported that they had no records of *Psychotria* being used as a drink or a substitute for coffee in Jamaica. Equally significant, Patrick Browne did not mention a use for this genus as he did with others when a use was known to him.

What is probably the real etymology of *Psychotria* was discovered when I encountered the following statement concerning *Psychotria* in *Hortus Jamaicensis* by John Lunan: "This was so named from the Greek of an herb in Dioscorides, so called from its delighting to grow in cool situations." (5). This name was then found in Book iv. i. of

Dioscorides (3) under the name Kestron. He states, "Kestron that which is called Psychotrophon because it is found in the coldest places, which ye heighth of a cubit, or more, 4 cornered, ye leaves long, soft, like ye oak jagged round about, smelling well, but they are greater towards ye root, & on the top of ye stalks lies ye seed encased in an ear as of Thymbra." Although this plant has been identified as *Betonica Alopecurus,* this is the first use of Psychotrophon from which Browne made *Psychotrophum* and later Linnaeus coined *Psychotria.*

Hence, *Psychotria* is derived from the Greek word ψύχω (psycho) meaning to breathe, to blow, to chill and the word τροφος (trophos) meaning growing in, an adjectival form of the verb τρεφειν (trephein) meaning to grow, to nourish. Browne coined the word *Psychotrophum* which means growing in a cool situation, probably because the species known to him were ". . . all natives of the woods, and grow best in a rich shady soil." (2). Although the etymology of *Psychotria* does not turn out to be what one would expect, this does not, of course, detract from the significant role this species has in the hallucinogenic beverage of the Kofán Indians and other aboriginal groups of the Amazon (figs. 1 & 2).

Acknowledgements: To mention all who aided me in this paper, which is clearly interdisciplinary, would require a long list of names. Special thanks is given to my professor, Dr. Richard Evans Schultes, who has been a constant inspiration and who turned my direction toward the Kofán ethnobotany. Also I wish to thank Mr. M. B. Borman, missionary-linguist to the Kofáns, for his patience and kind assistance in translating the language. The assistance of Mr. Leonard Muellner in helping me with the Greek was greatly appreciated. I also wish to acknowledge the efforts of and give credit to Dr. John D. Dwyer of St. Louis University, Department of Biology for studying my collections of *Psychotria*, #225 and #235 which as voucher specimens are now preserved in the Economic Herbarium of Oakes Ames in the Botanical Museum of Harvard University. May

Fig. 1. Kofán Shaman administering the hallucinogenic drink yáje prepared from *Psychotria viridis* and species of *Banisteriopsis*.

Plate 142

Fig. 2. Kofán Indians preparing to drink the hallucinogenic concoction during an all night yáje ceremony.

I express thanks to those whose names I did not include, especially those of the Gray Herbarium of Harvard University. Dr. Ara Der Marderosian and Dr. Kenneth M. Kensinger have permitted me to publish the following personal communication about their recent findings for which I wish to express my thanks.

Current investigation by Dr. Ara Der Marderosian of the Philadelphia College of Pharmacy and Science has apparently shown the presence of Dimethyltryptamine, a known hallucinogenic chemical compound, in plant material collected by the anthropologist Kenneth M. Kensinger of Temple University while carrying out field work among the Cashinahua Indians of Peru. This material was identified as Psychotria, possibly P. viridis by Homer V. Pinkley, and voucher specimens are now preserved in the Economic Herbarium of Oakes Ames in the Botanical Museum of Harvard University.

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GLAUCIUM FLAVUM CRANTZ FROM CAPE COD

In the summer of 1968, we discovered a single plant of *Glaucium flavum* in West Falmouth, Massachusetts (Barnstable County). The plant was growing in sand two-three feet above the high tide level near the West Falmouth Jetty. We returned to this area in August, 1969 and observed three separate colonies of *Glaucium* (20 plants in all), growing with the two dominant components of the beach flora, *Ammophila breviligulata* and *Artemisia Stelleriana.* Most of the plants bore at least one fruiting capsule.

The West Falmouth station is a slight range extension for Glaucium. It previously had been reported from Bristol County and Dukes County (the Elizabeth Islands), Massachusetts, and from Bristol, Newport and Prudence Island, Rhode Island (Seymour, 1969. Flora of New England). We were able to find one other New England record in the New England Botanical Club Herbarium, from Gay Head, Martha's Vineyard, Massachusetts (Dukes County).

Voucher specimens were collected and deposited in the University of New Hampshire, New England Botanical Club and Southampton College Herbaria.

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CHROMOSOME STUDIES IN HABENARIA

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The family Orchidaceae has received attention from numerous authors who have been interested in economic utilization of various taxa but less attention has been given to naturally occurring forms in temperate zone floras. Correll (1950) considered the family and its distribution north of Mexico in North America, and recognized twenty-six species, seventeen varieties and two hybrid taxa in the genus *Habenaria*. When more local treatments are considered it is noted that the number of taxa decreases and also that there is not complete unanimity concerning nomenclature. Thus, Fernald (1950) recognized twenty-six species, twelve varieties, four hybrids and four forms in the genus in north-eastern North America. Essentially the same taxonomic treatment was given by Donly (1963) and by Roland and Smith (1966), these latter describing ten species, five varieties, one form and one hybrid for the Atlantic provinces of eastern Canada.

Cytologically, the genus *Habenaria* has received only limited attention. Earlier reports included the work of Humphrey (1932, 1933 and 1934) and Harmsen (1943). Darlington and Wylie (1955) reported on only two of the local species and followed the earlier nomenclatural system in which the genus was split into at least seven genera (Rydberg, 1932, reprinted 1965). Subsequently only occasional reports have been published (Ornduff, 1967 and Löve, 1968). The present study was undertaken to determine the cytological nature of Nova Scotian species of the genus *Habenaria*.

The materials studied were collected chiefly in Queens County of Nova Scotia, but with scattered collections also from Kings, Antigonish and Inverness counties. Voucher specimens may be found in the herbarium of the Biology Department, Acadia University. Collections were made in the summers of 1964 and 1965, consisting of inflorescences,

root-tips and young shoots according to the conditions of the plant at time of collection. Where possible the three types of material were collected from the same plant. Materials were fixed in Farmer's fluid (three parts absolute alcohol to one part glacial acetic acid) for a maximum of twenty-four hours, after which they were transferred to seventy percent alcohol and stored under refrigeration. Root-tips and shoots were hydrolyzed in one normal hydrochloric acid for three minutes and then squashed in aceto-carmine. Flower buds were dissected and the pollinia smeared in aceto-carmine.

The chromosome numbers of twelve taxa of the genus *Habenaria* in Nova Scotia were determined (see Table I), with the numbers 42 and 84 being noted in somatic material. Of these, the numbers for *H. fimbriata* and *H. flava* have not been previously reported while the other counts confirm reports by Humphrey (1932, 1933, 1934) and Harmsen (1943). However, the count of $2n = 84$ for *H. hyperborea* is noteworthy. Humphrey had reported $2n = 42$ and Harmsen reported $2n = 84$ for this taxon. The latter

Table I. Chromosome numbers in the genus *Habenaria*

Taxon	$2n =$	previous record
× *H. Andrewsii* White ex Niles	42	42
H. blephariglottis (Willd.) Hook	42	42
H. clavellata (Michx.) Spreng.	42	42
H. dilatata (Pursh) Hook.	42	42
H. fimbriata (Ait.) R. Br.	42	
H. flava (L.) R. Br.	42	
H. Hookeri Torr.	42	42
H. hyperborea (L.) R. Br. var. *huronensis* (Nutt.) Farw.	84	42, 84
H. lacera (Michx.) Lodd.	42	42
H. orbiculata (Pursh.) Torr.	42	42
H. psycodes (L.) Spreng.	42	42
H. viridis (L.) R. Br. var. *bracteata* (Muhl.) Gray	42	42

author commented that the lower count is found in the more southerly part of the range of this species. Since Nova Scotia differs but little from Minnesota in latitude (where Humphrey obtained his material) and has milder winters, it might be questioned whether Harmsen's conclusion is valid. A study of material from a wider geographic area should elucidate this problem. The present study indicates that the somatic number of 42 is widespread in this genus.

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NEW CHROMOSOME COUNTS IN ULMUS AND PLATANUS

FRANK S. SANTAMOUR, JR.

Ulmus and *Platanus* are among the genera that have been given high priority in the project on Selection and Breeding of Shade and Ornamental Trees, begun at the U.S. National Arboretum in 1967. As part of an over-all genetics research program, we have attempted to obtain cytological data on all trees used for breeding and observation. Some of the plants are seedlings grown from seed obtained from native sources while others are older, established trees. This paper is primarily a report on the chromosome numbers of elm and plane species and varieties which have not been previously noted in the literature. The methods used in this study were standard aceto-carmine squash techniques with either root tips or pollen mother cells.

Voucher specimens of Arboretum trees, parent trees from which seed was collected, and seedling progenies are on deposit in the herbarium of the National Arboretum.

ULMUS

The first report on elm chromosome numbers was made by Krause (1930), who determined the haploid number in *U. montana* With. (*U. glabra* Huds.) to be $n = 14$. Krause (1931) also found $n = 14$ in *U. campestris* L. (*U. carpinifolia* Gleditsch.) and $2n = 28$ in *U. americana* Willd. Walker (1932) reported a different haploid number ($n = 15$) for *U. pumila* L. and *U. fulva* Michx. (*U. rubra* Michx.). She also determined the number of *U. americana* L. to be $n = 28$ or $n = 30$, and ascribed the difference to variation between trees. Later work, including that of Sax (1933a), has shown that 14 is indeed the normal haploid (and probably basic) chromosome number in elms and that most species are diploid with $2n = 28$. On the subject of *U. americana* L., Sax reported both the normal and pendulous forms as tetraploids with $n = 28$.

In the most recent edition of the "Chromosome Atlas" (Darlington and Wylie, 1955), two chromosome numbers are listed for *U. americana*. The diploid count of $2n = 28$ is ascribed to Krause (1930) — it should be Krause (1931) — while the reference for the tetraploid number is Sax (1933a). The question immediately arises as to whether the "*U. americana*" of the Krause study was the same species that Linnaeus described. Willdenow is given by Krause as the authority for the scientific name; and since Krause obtained his material as seed or seedlings from a commercial firm, the problem of identification is more difficult. In view of past and present cytological studies on *U. americana* L., it appears likely that Krause's plants were not true American elm and that his diploid count may be eliminated from further consideration.

Recent studies in American elm, along with other elm species, are reported below.

U. americana L. $n = 28$

Five trees (ST-324, 331, 334, 336, 341) growing at the National Arboretum. Received as seedlings from U.S. Soil Conservation Service, Manhattan, Kansas in March, 1954.

The author has previously determined native trees in Massachusetts and Pennsylvania to be tetraploids.

U. americana var. *floridana* (Chapm.) Little $2n = 56$

Seedlings raised from seedlot NST-44, collected by A. E. Squillace, U.S. Forest Service, in Fort White, Florida, in March, 1968.

U. alata Michx. $2n = 28$

Seedlings raised from seedlot NST-45, collected by A. E. Squillace, U.S. Forest Service, in O'Leno Park, Florida, in March, 1968.

U. crassifolia Nutt. $2n = 28$

Seedlings raised from seedlot NST-8, collected by L. Hinton, Jr. from native trees in Houston, Texas, in November, 1967.

U. macrocarpa Hance $n = 14$

Tree ST-370 growing at National Arboretum. One of five surviving trees raised from seedlots (P.I. 138008-

138017) received in 1940 from garden of Summer Palace, Peiping, China.

U. parvifolia Jacq. $n = 14$

Tree ST-300 of accession NA 25526. Received in 1929 as P.I. 82487 from Imperial Botanical Garden, Keijo, Japan.

U. serotina Sarg. $n = 14$

Tree ST-305 of accession NA 18375. Source unknown. Tree now 35 feet tall.

PLATANUS

The earliest cytological study in *Platanus* was made by Winge (1917), who reported $n = 21$ for *P. orientalis* L. However, Pizzolongo (1958) has determined that Winge's specimen was not oriental plane but *P.* × *acerifolia* (Ait.) Willd., the putative hybrid or hybrid derivative of the cross between *P. orientalis* and *P. occidentalis* L. Later interpretations of $n = 8$ (Brouwer, 1924) and $n = 10$-11 (Bretzler, 1924), for *Platanus* species have been shown to be incorrect: Sax (1933b) found $n = 21$ in both *P. occidentalis* and *P.* × *acerifolia* and Pizzolongo (1958) reported that *P. orientalis* was also a diploid with $n = 21$, $2n = 42$ chromosomes.

The chromosome numbers of individuals of the above species were checked and, in addition, the following counts were made:

P. mexicana Moric. $2n = 42$

Seedling plant (NA 29764) supplied by L. Lowrey, Houston, Texas, in 1967. Grown from seed collected at Horsetail Falls, south of Monterey, Mexico.

P. occidentalis var. *glabrata* (Fern.) Sarg. $2n = 42$

Seedling plant (NA 29763) supplied by L. Lowrey, Houston, Texas, in 1967. Grown from seed collected along Blanco River in central Texas.

P. racemosa Nutt. $2n = 42$

Seedlings raised from seedlot NST-32, collected by J. Dourley, Rancho Santa Ana Botanic Garden, Claremont, California, in 1968.

P. wrightii Wats. $2n = 42$.

Seedlings raised from seedlot NST-106, collected by W. E. Earle in the New River Mountains, Arizona, in 1968.

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CHROMOSOME NUMBERS OF SOME BRAZILIAN ANGIOSPERMS

JAMES R. COLEMAN AND LYMAN B. SMITH

The material for this study was collected by the senior author while he was serving as research taxonomist at the Instituto de Botânica of São Paulo, Brazil. The chromosome numbers were determined by the senior author and the material was identified by the junior author, with the exception that *Justicia leucophloea* was determined by Mr. Dieter Wasshausen.

The methods used in the cytological studies are identical to those described in a previous paper (Coleman, 1968). A complete set of voucher specimens has been deposited in the United States National Herbarium.

Chromosome numbers are reported for 16 species (Table 1). The report of $n = 8$ for *Eryngium ebracteatum* confirms previous reports (Hamel, 1955; Bell and Constance, 1966) for that species as does the count of $n = 12$ confirm previous reports (Goodspeed, 1923; Lewis et al, 1962) for *Nicotiana glauca*. The remaining 14 reports are evidently the initial reports for the respective species.

The report of $n = 28$ for *Justicia (Rhytiglossa) leucophloea* supports the position that *Rhytiglossa* is not distinct from *Justicia* (Wasshausen, personal communication). Although counts for species of *Justicia* range from $n = 9$ (Pal, 1964) to $n = 17$ (Ellis, 1962), the most frequently reported number is $n = 14$ (Grant, 1955). The report of $n = 28$ is the first report of polyploidy in the genus.

The reports for *Lafoensia pacari*, $n =$ c. 10, (Lythraceae), *Deianira erubescens*, $n = 14$, (Gentianaceae) and *Prestonia acutifolia*, $n =$ 16-17, (Apocynaceae) are evidently the initial reports for these genera.

The report of $n = 12$ for *Loasa rupestris* is the first report of that number in *Loasa*. The occurrence of $n = 12$ in *Loasa* is of some interest since Darlington and Ammal (1945) considered the genus dibasic with $x = 7$, 15 and at

least one species has been reported as $n = 19$ (Tschischow in Cave, 1963). It may therefore be hypothesized that the $n = 19$ species possibly had an amphidiploid origin from hybridizing $n = 7$ and $n = 12$ species.

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Table I

	n =	Locality
ALISMACEAE		
Echinodorus subalatus (Mart.) Griseb.	c.14	State of Bahia: Correntina. *530
LEGUMINOSAE		
Camptosema coriaceum (Nees & Mart.) Benth.	11	State of Bahia: Veredãozinho, Município of Correntina. 549
Crotalaria breviflora DC.	16	State of São Paulo: Parque do Estado, São Paulo. 604
TROPAEOLACEAE		
Tropaeolum glaziovii Fr. Buchenau	c.14	State of Minas Gerais: Gruta de Lagoa Santa, near Lagoa Santa. 586
LOASACEAE		
Loasa rupestris Gardn.	12	State of Bahia: Gameleira, Município of Irecê. 475
LYTHRACEAE		
Lafoensia pacari St. Hil.	c.10	State of Bahia: Gameleira, Município of Irecê. 488
UMBELLIFERAE		
Eryngium ebracteatum Lam.	8	State of São Paulo: 9 km south of São José dos Campos. 605
GENTIANACEAE		
Deianira erubescens Cham. & Schlecht.	14	State of Goiás: Alvorada, between Posse and Formosa. 565
APOCYNACEAE		
Prestonia acutifolia (Benth.) K. Schum.	16-17	State of Goiás: Alvorada, between Posse and Formosa. 562

SOLANACEAE		
Nicotiana glauca Graham	12	State of Bahia: Gameleira, Município of Irecê. 489
Solanum paniculatum L.	12	State of Bahia: Correntina. 524
Solanum asperum L. C. Rich	12	State of Bahia: Correntina. 536
Solanum rufum Sendtn.	12	State of Goiás: Alvorada, between Posse and Formosa. 563
Solanum sp.	12	State of Bahia: 22 km south of Gameleira, Município of Irecê. 479
SCROPHULARIACEAE		
Angelonia biflora Benth.		State of Bahia: Gameleira, Município of Irecê. 490
ACANTHACEAE		
Justicia leucophloea (Nees) Wasshausen**	28	State of Rio de Janeiro: Parque Nacional Serra dos Orgãos. 583

*Collection numbers those of senior author.

**_Justicia leucophloea_ (Nees) Wasshausen, comb. nov. _Rhytiglossa leucophloea_ Nees in DC. Prodr. 11: 343. 1847. Although the combination has been published twice in synonymy, in the Prodromus and in Index Kewensis, it has not been made validly before.

ON A WEED SPECIES OF RORIPPA. — The area of origin and proper identity of widespread weeds are often difficult to establish. This is particularly true when different names are used in different parts of the world for the same species. A case in point is that of *Rorippa indica* (L.) Hiern. We have seen specimens of the apetalous variety of this species collected from a number of places in the Western Hemisphere, especially in Brazil; in the West Indies (Jamaica and Puerto Rico) and in the United States from Louisiana and from near Portland, Oregon. Besides *R. indica*, the names most commonly used for this species on the specimens and in the books are *Rorippa heterophylla* (Blume) Williams and *Rorippa montana* (Wall.) Small, but specimens were found misidentified in such remote genera as *Sisymbrium* and *Cardamine*.

Rorippa indica is native in Eastern Asia and is present there in both petalous and apetalous infraspecific taxa. All of the evidence I have been able to assemble supports the position taken by Hochreutiner[1] that the plants of this weedy species can readily be accommodated in two varieties, var. *indica* and var. *apetala*. The original material of Linneaus possesses petals and the plants of var. *indica* are slightly taller with shorter siliques than is characteristic of var. *apetala*. The American material should be referred to *R. indica* (L.) Hiern, var. *apetala* (DC) Hochr. Hiern[2] definitely transferred the epithet *indica* to *Rorippa*, thus making superfluous the same transfer made by Hochreutiner (*l.c.*). The transfer by Hiern was made on an unnumbered page following p. XXV under a heading, "additions and corrections". The place is sufficiently obscure to be easily overlooked, but the index does give *Rorippa indica* and refers to p. XXVI. *R. heterophylla* and *R. montana* appear to be straight synonyms of *R. indica*. The name *Nasturtium montanum* was given in Wallich's list without description. I have not attempted to determine the first place a description was supplied because that is irrelevant to the present

[1]Hochreutiner, B. P. H. Candollea **2:** 370-371. 1925.
[2]Hiern, W. P. Cat. Welw. Afr. Pl. pt. 1, following p. XXV. 1896.

consideration. Certainly Small's use of the name in the appendix to his Flora of Southeastern United States (Ed. 2) is not correct.

It is interesting that the apetalous type of *R. indica* is the one that has become the weed rather than the variety with petals. It is a safe assumption that var. *apetala* does not require insect pollination. It is most probably both self compatible and predominately autogamous. Thus, it undoubtedly possesses the appropriate breeding system to spread far outside of its native area. This conforms to expectations.

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VIBURNUM WURDACKII, A NEW PERUVIAN SPECIES

T. R. DUDLEY

Most botanists will concur that an immense need exists for accelerated exploration, collecting, and systematic and ecological studies in Latin America. South America, Central America and Mexico have long been recognized as major centers of diversity and evolution within the genus *Viburnum* (Caprifoliaceae). The studies on South American *Viburnum* (Killip and Smith 1929, 1930; Killip 1937), although adequate when published for herbarium material then extant, obviously cannot be expected now to be definitive. A modern, critical revision of the Andean taxa is much needed. This fact is greatly emphasized as the floras of remote, unexplored, and previously uncollected areas are gradually studied concurrently with the development of modern methods and concepts in systematics and ecology.

Whereas the taxa of *Viburnum* from two other great centers of heterogeneity of Eastern Asia and North America are rather thoroughly collected and taxonomically documented, the *Viburnum* taxa of Latin America are essentially unknown in the broad sense of taxonomic relationships. Increased field work in Latin America and *ne plus ultra* analysis of all collections of *Viburnum*, as well as of other genera, will without doubt yield new taxa, define and solve outstanding problems of plant multiformity and evolution in the tropics, and interpret inter-taxa affinities.

The Peruvian taxon of *Viburnum* described here is based on analysis of two collections discovered by the author in several herbaria, while surveying *Viburnum* for projected revisionary and monographic treatment. The line drawing was prepared by Mrs. Regina O. Hughes, formerly illustrator for New Crops Division, U.S. Department of Agriculture, Beltsville, Maryland. The photograph of the inflorescence was provided by Dr. J. J. Wurdack from his collection of field photographs.

Viburnum wurdackii Dudley, sp. nov.

Quae species affinis videtur *V. weberbaueri* Graebn. (= *V. reticulato* Ruiz & Pavon ex Oerst. — *sensu lato*) sed foliis sinuato-undulatis (nec valde dentatis), late ovato-ellipticis, maioribus, subtus toto densis fulvo-tomentosis implexis e pilis stellatis dimorphis compositi, inflorescentiis radiis pedunculo maioribus et robustiore, floribus multum congestioribus sessilibus vel interdum subsessilibus, corolla per anthesin majore 5-8 mm. diametro dense pubescentibus e pilis stellatis tecti, lobis margine valde et aequaliter papillosis apice ovato-spathulatis, calycis lobi rotundi margine ciliolati, ovario calyce corollaque toto densis pilis stellatis fulvis implexis tectis, fructibus immaturis pubescentibus e pilis stellatis densis compositis differt.

Frutex vel arbor parva, 3-5 m. alta; ramis, ramulis, foliis subtus, petiolis, inflorescentiis, ovariis, calycinis lobisque dense crasseque luteolis ad fulvis indumento obsitis. Folia subcoriacea, estipulata, late ovato-elliptica vel raro parum obovata, (6-) 10-16 (-20) cm. longa, 4-9 (-11) cm. lata, apice acuta vel rotundata, mucronata, basi subtruncata ad rotundata, margine sinuato-undulata, supra viridia sed semper cum pilis stellatis minutis aeque dispersis disjunctis tecta, subtus pallidiora densiore fulva dimorpha pubescentia e pilis stellatis appressis interspersis pilis stipitatis composita, nervis primariis 4, subtus prominente elevatis (sicut costa media), supra uterque levissime impressis, nervis secundariis transversis subtus distincte elevatis, supra uterque levissime impressis; petioli 1-2 cm. longi, canaliculati, dense pubescenti. Cyma corymbiformis, 7-12 (-20) cm. longo et lato, pilis luteolis vel fulvis crebris appressis, pedunculo 1-6 cm. longo, crasso, radii primarii 3-6, usque ad 6 cm. longi; bracteae bracteolaeque plerumque minutissimae anguste obovatae cauducae pubescentae; flores numerosi congesti, sessiles vel interdum subsessiles in radiis ordinis tertii siti basi bracteis bracteolisque oppositis suffulti; ovarium 1-2 mm. longum, campanulato-cylindricum densim pubescens; calycis lobi rotundo-orbicularis, 0.5-0.6 mm. longi, densim pubescentes, margine ad apicem ciliolati; corolla alba, rotata, 5-8 mm. diametro, 2.5-4 mm. longa, extus pubescens, lobis rotundato-spathulatis pariter aequaliter apillosis; stamina corolla superanta, corollae basi affixa, filamentis 3-4.5 mm. longis, antheris flavis, oblongo-ovatis, c. 1 mm. longis. Drupa immatura, viridia, 3-4 mm. longa, 2-3 mm. lata, elliptica, indumento denso e pilis stellatis tecta, apice praecipue 5-10 pilis fasciculatis vel simplicibus conspersa, calyce styloque persistentibus coronata, stylo cylindrico, c. 0.5-0.8 mm. longo, calycem paulo superante, stigmate capitato trilobulato.

TYPE LOCALITY: Peru, Molinopampa-Diosan pass in Provincia de Chachapoyas, Departamento de Amazonas; the type is *J. J. Wurdack* 1648.

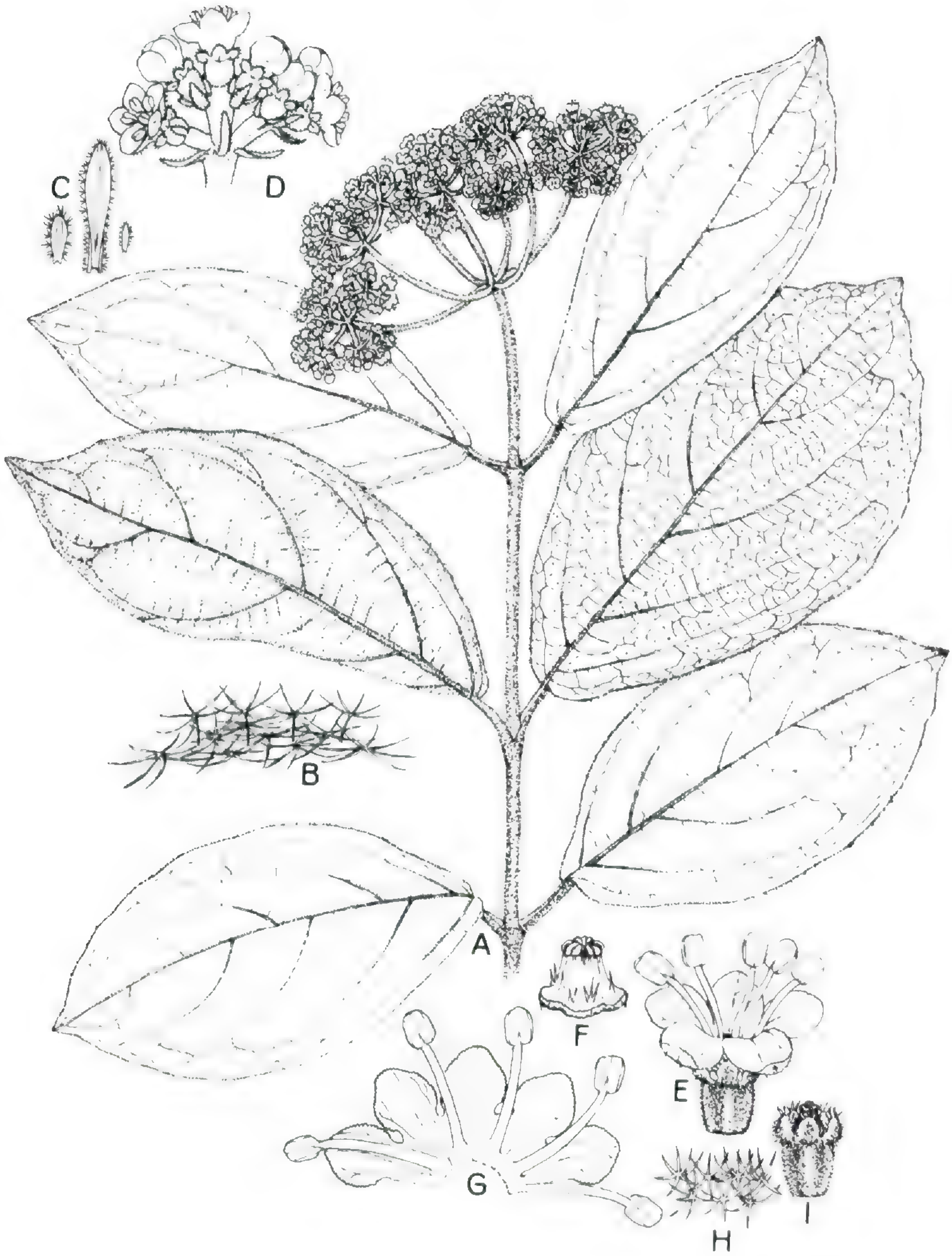

Fig. *Viburnum wurdackii* Dudley. Holotype: *J. J. Wurdack* 1648. A. Habit × 1, second leaf from bottom, right side shows upper surface; second leaf from bottom, left side shows lower surface. B. Indumentum on leaf lower surface of intermeshing appressed stellate hairs and interspersed stipitate stellate hairs, × 40. C. Bracteoles subtending secondary and tertiary rays of inflorescence, size is variable according to position, × 4. D. Cluster of flowers on tertiary

DISTRIBUTION: Presently known only from two Peruvian collections in Departamento Amazonas. It is recorded as a white-flowered shrub or tree 3-5 m. tall, growing in moist scrub forest at 1500 m. *(F. Woytkowski)* and 2700-3100 m. *(Wurdack)*.

PERU. PROVINCIA DE CHACHAPOYAS, Departamento de Amazonas: south side of Molinopampa-Diosan pass, 8 Aug. 1962, *J. J. Wurdack* 1648 (US, holotype; NY, isotype); Departamento de Amazonas: Mendoza, 6 Aug. 1963, *F. Woytkowski* 8124 (GH, MO).

The new species described above resembles *Viburnum weberbaueri* Graebn. (Bot. Jahrb. Syst. 37: 433. 1906) in some respects, but it is clearly distinguished as follows. The leaves of *V. wurdackii* Dudley are larger, broadly ovate to elliptic, with sinuate to undulate margins and with dimorphic indumentum on the lower surface composed of stipitate stellate hairs interspersed with heavily matted, intermeshing and appressed stellate hairs.

In *Viburnum weberbaueri*, the leaves are mostly obovate or oblong-ovate, and dentate or denticulate, at least above the middle. The stellate hairs on the lower leaf surface are of variable density and are consistently stipitate, and the indumentum on the upper leaf surface is much sparser than that of *V. wurdackii*. Accordingly, the upper leaf surface of *V. weberbaueri* often appears glabrous. The inflorescence of *V. wurdackii* with 3-6 primary rays and heavier, more robust rays and peduncle is larger than that of *V. weberbaueri* with 5-7 primary rays. A significant difference is noted in the bracts subtending the rays of the inflorescence. Those of *V. weberbaueri* are oblong-lanceolate, retained through anthesis and measure up to 2 cm. long (subtending the primary rays). The bracts of *V. wurdackii* are early caducous and at most measure 0.8 mm. long. The flowers of *V. wurdackii* are usually sessile, very

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inflorescence rays showing disposition of bracteoles, × 5. E. Flower at anthesis, × 10. F. Style and top of ovary, × 20. G. Corolla spread out, × 10. H. Dense indumentum of stellate hairs from surface of ovary, × 40. I. Young ovary shortly after corolla has dropped, × 10.

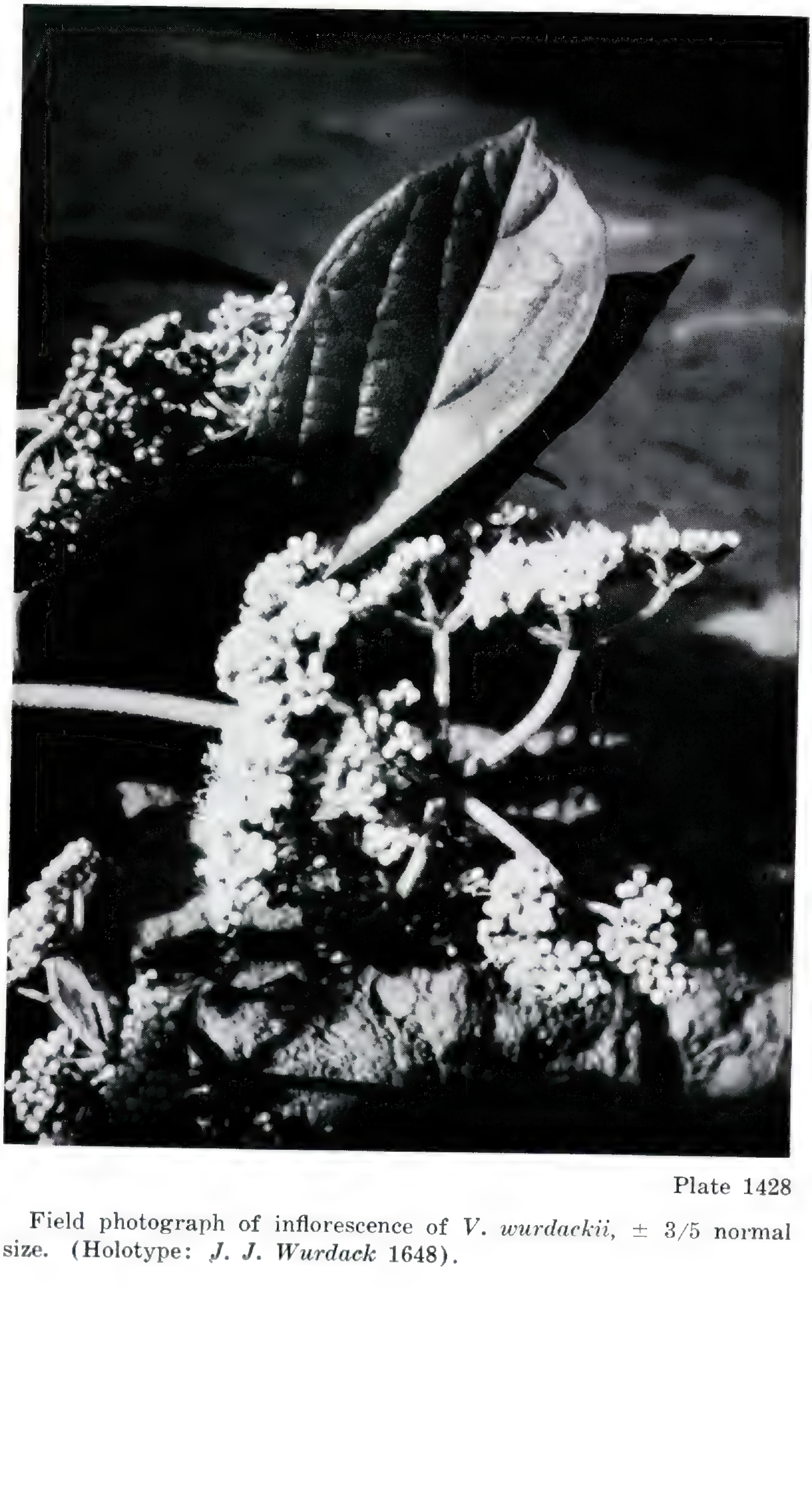

Plate 1428

Field photograph of inflorescence of *V. wurdackii*, ± 3/5 normal size. (Holotype: *J. J. Wurdack* 1648).

densely congested, and larger than the short pedicelled flowers of *V. weberbaueri*. The corollas of *V. weberbaueri* are glabrous, or at most with few (three or four) stellate hairs, lobes are smooth, or weakly and unevenly papillose. The corolla lobes of *V. wurdackii* are densely pubescent (of more than 20 intermeshing stellate hairs), and strongly and evenly papillose. The calyx lobes of *V. weberbaueri* are acute and almost glabrous (except of apical hairs) in contrast with the rounded or obtuse, densely pubescent and ciliate calyx lobes of *V. wurdackii*. The ovaries of *V. weberbaueri* are glabrous or occasionally sparsely pubescent, with few readily displaced furcate and stellate hairs; those of *V. wurdackii* are densely pubescent with intermeshing stellate hairs that persist on the fruit at least until half mature.

Unfortunately, mature fruit was not present in the specimens examined. Only the *F. Woytkowski* specimen from MO has immature fruit. The duplicate (GH) did not have fruit, nor did the *J. J. Wurdack* specimens. The plant is named for Dr. J. J. Wurdack, the original collector of the new species who led the Smithsonian Institution Peruvian Expedition in 1962, and is internationally recognized for his investigations of the Melastomataceae.

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A RANGE EXTENSION FOR *SUAEDA AMERICANA* IN NEW ENGLAND — *Suaeda americana* (Pers.) Fern. was found for the first time in Rhode Island on the salt marsh at Jerusalem in September, 1968. According to Fernald, this species has a range from Côte Nord, Quebec, south to southern Maine. Gleason cites it as extending from Quebec to Nova Scotia and Maine.

Several hundred plants of *Suaeda americana* grew mixed with *S. linearis* (Ell.) Moq. on the upper levels of the marsh at the base of the dune between the marsh and Point Judith Pond, and extended into lower levels where *S. linearis* did not grow. Where the two species of *Suaeda* grew together, each species was distinct with no evidence of intergrading.

The tidal marsh at Jerusalem lies between Potter Pond and Point Judith Pond and behind a barrier beach bordering Block Island Sound. When present conditions are compared with a map made in 1839, that part of the marsh where the *Suaeda* is now abundant was once open pond, the breachway was west of the present location, and the dune was made when the present breachway into Point Judith Pond was dredged. Loose sand still extends from the dune several hundred feet into the marsh.

Suaeda linearis is a common species found on most tidal marshes in Rhode Island. *Suaeda americana* was probably introduced when the breachway was dredged, possibly in debris clinging to the dredge from a previous work site.

A few plants of *Chenopodium leptophyllum* Nutt., another species new to Rhode Island, were also found in the sandy areas extending from the dune into the marsh, but since the range of this species is from Maine to Virginia, finding it was not as unexpected as finding *Suaeda americana*.

A colony of perennial saltwort, *Salicornia virginica* L. was also found here and may have been introduced at the same time as the other species named, but while it is rare in Rhode Island, it has been reported previously. *Viburnum dentatum* L., another relatively rare species, and one which is usually found near the sea shore in Rhode Island was

found growing on an island in the marsh in close proximity to *V. recognitum* Fern.

Voucher specimens dated September 23, 1968 have been deposited in the Herbarium of the University of Rhode Island.

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NOTES ON RECENT BOOKS

Nightshades — The Paradoxical Plants by Charles B. Heiser, Jr., W. H. Freeman and Company, San Francisco. 1969.

This anecdotal yet authoritative little book on the Solanaceae is intentionally aimed at the popular market. The treatment of the genera is rather uneven. Many of the "old wives tales" associated with some of the species are discussed often without seeming resolution. The chapter on Burbank and the "Wonderberry" is unduly labored and prolonged.

The discussions of the geographical and genetic origins of cultivated members of the family, along with a useful bibliography, are valuable parts of the book from the botanist's viewpoint.

Handbook of North American Nut Trees, Richard A. Jaynes, Editor. Humphrey Press, Geneva, N. Y. 1969.

This is a horticultural book and without much doubt has the most authoritative sources of cultural information on nut trees that are now being grown or can be grown in this country. The contributors are specialists in their fields.

There is much for the botanist, especially the discussions of natural and extended ranges of our native species and the records of spontaneous hybrids.

What may be the final report on *Castanea dentata* is included in the chapter on chestnuts by the two greatest authorities on this almost extinct and once noble member of our flora.

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BOOK REVIEW

A Model Flora of Ohio — "The Monocotyledoneae" by E. Lucy Braun. The Ohio State University Press. Columbus, Ohio. 1967. 464 pages. Price $10. Profusely illustrated.

Here is another book by the indefatigable Lucy Braun. And, as usual, it is a good one. This imposing volume, the first of a series entitled "The Vascular Flora of Ohio", extends "from cat-tails to orchids", i.e. *Typhaceae* through *Orchidaceae*. The title of the book, and the *Bromus* illustration on the cover are gilt-edged; so is the arrangement of printing, subject matter, and illustrations. We have as a beginning a "preface" instead of a "foreword" (cf. Fowler's "Modern English Usage"), and this general good quality continues throughout the book. In this preface we read that "the usability is not only for the student or botanist, but also by the amateur and the fieldworker in any of the natural sciences" and that "the illustrations have been drawn from fresh specimens whenever possible except for a large proportion of the Pondweeds, Rushes, Grasses, and Sedges".

In the Introduction, which occupies nine pages, there is a series of maps with comment on them, and comment also on some of the troubles of nomenclature. These maps, as might be expected of Miss Braun's wide interests, cover Ohio phenomena: January temperatures, length of average growing season, snowfall, geological maps of rock types and of glaciation, and a detailed landform map.

Practically all of the native Ohio species are illustrated by fine line drawings. There is a general dearth in the literature of illustrations made from living plants, and such illustrations may help to bridge the gap between Gray's Manual and Gleason's "Britton & Brown". One could wish for more detailed drawings of spikelets in the grasses, especially if drawn from living specimens, since they are such a difficult group for anybody. Even in *Carex* the drawings are excellent, and Miss Braun in *Carex* nomenclature fortunately follows Hermann, who knows *Carex*. The drawings are especially beautiful in the *Liliaceae* and *Orchidaceae*.

For each native species there is a distribution map with the counties outlined, as in Deam's "Flora of Indiana". It will be interesting to compare these Indiana and Ohio plant maps, and also similar maps in some of the Southern states. This comparison would not do for New England, where the counties are very large.

There will always be some differences of opinion as to nomenclature. I would like to see the name *Arisaema triphyllum* reestablished for our common northern species of jack-in-the-pulpit. Even Linnaeus, who was familiar with the Burser Herbarium, concluded that the "Brazilian" specimen came from Canada, and the subject was long ago admirably treated by Juel, under the title "The French apothecary's plants in Burser's Herbarium", in RHODORA, vol. 33 (1931). Also I should like to see the differences mentioned in the key to *Lilium superbum* and *L michiganense* brought out more clearly in the illustrations. I am so obtuse that I cannot make out the distinction between the two species, although I have collected both of them.

The name "dog's-tooth lily" for *Erythronium* is a new one. It is far better than the saccharine "fawn lily" and "trout lily", both manufactured names; but lacks the fine historical background and long usage of the real common name "dog's-tooth violet". The name "violet" was not at all confined to the genus *Viola* throughout the ages, but included many flowers with the "ion" or violet coloration of plants which belonged also to the *Cruciferae* and *Liliaceae*. The European "erythro-ion" (i.e. *Erythronium*) has purplish flowers. The subject together with a discussion of many similar problems, is well taken up by E. A. Lopez in "Apuntes para un concepto del genero y la especie en la Historia de la Botanica" in *Anales del Jardin Botanico de Madrid*, vol. 34: 315-355 (1944).

One more point: the hazy *Eleocharis palustris* of Europe should be omitted. It has no real basis in America, but the native *E. Smallii* is instead founded on identifiable material. See RHODORA 49: 64-65 (1947) and North American Flora 18, pt. 9: 526 (1957).

As evidence to show that he has read the text carefully, the reviewer is expected to come up with at least some trifling errors. These are hard to find, and consist of a few misspellings in the index, some of which are reflected in the text. The correct examples are *Anthoxanthum puelii*, *Carex hormathodes*, *Carex tuckermani*, *Rhoeo*, and *Epipactis helleborine*; also the name is Lumnitzer, and not "Lamnitzer" under *Carex varia*, but the error comes from Gray's Manual. But such trivialities occur in every publication, and they do not really detract any from this admirable piece of work.

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ERRATA

Page 7, line 2 for subtropicals read subtropical
Page 8, 4th line from bottom eliminate "g"
Page 25, line 7 for Grisch read Griseb.
Page 27, line 34 for *Erichitites* read *Erechtites*
Page 27, line 34 for *hieraceifolia* read *hieracifolia*
Page 32, line 1 for *brachycarps* read *brachycarpus*
Odd pages 37-57, heading for Bromelliaceae read Bromeliaceae
Page 123, -line 4 for Fucus read *Fucus*
Page 183, line 5 for **Bigeloy** read **Bigelow**
Page 419, Fig. 1 caption, line 3 for purpurea read *purpurea*
Page 452, caption Fig. 18 for *Elakatothrix* read *Elaktothrix*
Page 465, caption Fig. 34 for *Glenodinium* read *Glendodinium*
Page 465, caption Fig. 39 for *Rhodomanas* read *Rhodomonas*

VALIDATION OF THE NAME DAHLIA AUSTRALIS

Article 33, International Code of Botanical Nomenclature, 1966, states, "A new combination . . . is not validly published unless its basionym . . . is clearly indicated and a full and direct reference given to its author and original publication. . . ." Compliance with this article has proved useful in the elimination of errors and confusion. On page 378 of Rhodora 71 (No. 787) I proposed the new combination *Dahlia australis* failing to make reference to its basionym until two pages hence where it is given under the heading of *Dahlia australis* var. *australis*. Mr. Robert M. King noted this and suggested to me such an arrangement might *not* be in compliance with the code. I agreed that, in the manner I had presented it, the basionym was not "clearly indicated." In an effort to correct this omission, thereby avoiding further confusion and perhaps ultimate invalidation of the name, I have repeated here the essential nomenclatural details of *Dahlia australis*.

Dahlia australis (Sherff) Sorensen, comb. & stat. nov.

TYPE: MEXICO: OAXACA: Cerro de San Felipe, 2500 m., 1 Sep. 1897. *Conzatti & Gonzalez* 543 (Holotype: GH!).

Basionym: *Dahlia scapigera* var. *australis* et f. *australis* Sherff, Am. Jour. Bot. 34: 143. 1947. Type: that of *Dahlia australis* as indicated above.

For purposes of possible future competition in consideration of the rule of priority (Article 11, l.c.), the date of publication of the name *Dahlia australis* is the publication date of this correction. (For additional notes and descriptions of *D. australis* and its infraspecific taxa, see the full treatment in Rhodora 71: 378 ff.)

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STUDIES IN EUPATORIUM (COMPOSITAE)
I. REVISION OF EUPATORIUM BELLIDIFOLIUM AND ALLIED SPECIES

J. L. GRASHOFF AND J. H. BEAMAN[1]

Eupatorium bellidifolium Benth. is the earliest described member of a closely allied complex of herbaceous Mexican and Central American species of section *Eximbricata*. The complex also includes *E. lasium* Robins., concerning which Robinson (1923) noted that "This beautifully distinct species belongs in a small group striking by reason of their loose inflorescence." Three other species which he included in the group (Robinson 1923; 1934) are *E. muelleri* Sch. Bip. ex Klatt, *E. choricephalum* Robins., and *E. arsenei* Robins. During an examination of various Mexican and Central American species of *Eupatorium* in the Gray Herbarium and the U. S. National Herbarium a collection from Honduras determined as *E. muelleri* came to our attention. It appeared to be misdetermined but nevertheless belonged with the complex. In connection with the study of this and several similar specimens, which are here described as a new species, we have found it desirable to review the group as defined by Robinson and to prepare a revision of these species.

Although Robinson's conclusion that the species are closely related seems well justified, they do not appear to be as sharply delimited from other species of *Eupatorium* as his statement concerning the loose inflorescence might imply. Their relatedness is suggested also by the herbaceous habit,

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[1]The project was initiated with support of NSF Grant GE-4051 for Undergraduate Research Participation at Michigan State University and continued while Grashoff was a summer participant in a similar program at the Smithsonian Institution and Beaman held a National Academy of Sciences — National Research Associateship at the Smithsonian. We appreciate the facilities for the study provided by the curators of the Gray Herbarium, Field Museum, University of Michigan Herbarium, and the U. S. National Herbarium. We are grateful to Dr. M. Kabalin for editing the Latin diagnosis.

generally cordate leaves with dentate or crenate margins, corollas with ampliate throats, the shape, size and pubescence of the achenes, and brittle pappus. But these characters individually or collectively do not afford a clear distinction of the group. Still other species which are not distantly related include *E. pazcuarense* H.B.K., *E. rothrockii* A. Gray, *E. mariarum* Robins., *E. aschenbornianum* Schauer, and *E. ciliatum* Less. An investigation of all such species, however, is at present beyond practical limits.

Key to the Species

1. Pedicels and outer phyllaries glabrous 2
1. Pedicels and/or outer phyllaries pilose or with glandular trichomes 3
   2. Leaves cordate, crenulate, extending well up the stem into the inflorescence although gradually reduced upward; heads less than 7 mm wide, with ca 50 florets ..... 1. *E. anchisteum*
   2. Leaves ovate to orbicular, acuminate, cuneate or truncate, seldom cordate, confined to the lower 1/4 of the plant, or if present above then much reduced; heads 6-9 mm wide, with ca 85-125 florets ..... 2. *E. muelleri*
3. Inflorescence branches, pedicels, and outer phyllaries with glandular trichomes; leaves subrosulate; phyllaries linear; heads few on long pedicels ..... 3. *E. bellidifolium*
3. Inflorescence branches, pedicels, and outer phyllaries with non-glandular trichomes, phyllaries lanceolate to ovate; heads few to many, usually on short pedicels 4
   4. Leaf blades with nerves branching from above the base, with large white moniliform trichomes on both surfaces; head ca 8 mm wide, with 60-87 florets ..... 4. *E. lasium*
   4. Leaf blades with nerves branching at the very base, often appearing glabrous at least on the lower surface; heads 5-7 mm wide, usually with 30-60 florets ..... 5. *E. choricephalum*

1. Eupatorium anchisteum Grashoff & Beaman, sp. nov.

Type: Honduras. Morazan: region of El Jicarito, above El Zamorano, 900-1000 m, *Paul C. Standley* 27471, Nov. 14, 1950 (US 2024848, holotype, MSC photo 9237; GH).

Herba perennis erecta, 4-6 dm alta. Caulis gracilis, basi densissime cum sordidis trichomatibus duplo-pilosus. Folia opposita membranacea, superne gradatim parvescentia. Petioli 1.5-3 cm longi, duplo-pilosi. Laminae 2.5-5 cm latae, 3.5-5 cm longae, orbiculari-ovatae, acuminatae, cordatae, crenatae ad crenulatae, utrinque sed praecipue inferne secus venas cum tricomatibus moniliformibus grandibus albidis, 3-7

Plate 1429

Figure 1. *Eupatorium anchisteum* Grashoff & Beaman, holotype. Insert: head and floret from *Steyermark* 30650 (F). Many of the fragile pappus bristles have fallen away (× 2.2).

nervis a brevi-acuminatae basi maxime diffusis. Inflorescentia in paniculam terminalem laxe disposita, ramis subglabratis, pedicellis 7-15 mm longis. Capitula 5 mm alta, cum ca 50 flosculis. Involucra campanulata. Phyllaria ca 20-22, obtusa ad acuta, subaequaliter herbacea, glabra, lanceolato-ovata ad oblanceolato-obovata, scarioso-marginata, ciliata. Corollae ca 2.7 mm longae, albae, ad lobulos pubescentes, lobuli 0.5 mm longi. Achaenia nigra, ca 1.5 mm longa, praecipue secus venas cum trichomatibus bifidis. Setas pappi multae, albae, barbellatae, fragiles, 3 mm longae.

Erect perennial herb 4-6 dm tall; stem slender, terete, densely doubly pilose below with grayish trichomes; leaves opposite, membranaceous, becoming gradually smaller above; petioles 1.5-3 cm long, doubly pilose; blades 2.5-5 cm wide, 3.5-5 cm long, orbicular-ovate, acuminate, cordate, crenate to crenulate, with white moniliform trichomes on both surfaces and especially along the veins beneath, veins 3-7, branching from the short-acuminate base; inflorescence a loose terminal panicle, the branches subglabrous, pedicels 7-15 mm long; heads ca 5 mm high, 6-7 mm wide, with ca 50 florets; involucre campanulate, phyllaries 20-22, obtuse to acute, subequal, herbaceous, glabrous, lanceolate-ovate to oblanceolate-obovate, scarious margined, ciliate; corollas 2.7 mm long, white, pubescent on and near the lobes, lobes 0.5 mm long, achenes black, ca 1.5 mm long, with bifid trichomes especially along the ribs; pappus of numerous fragile white barbellate bristles 3 mm long. Figure 1.

Additional specimens examined. GUATEMALA: CHIQUIMULA: along Rio Tacó between Chiquimula and Montaña Barriol, 3-15 mi NW of Chiquimula, 500-1200 m, *Steyermark* 30650 (F). JALAPA: mountains along the road between Jalapa and Paraíso, 1400-1700 m, *Standley* 77248 (F); vicinity of Jalapa, 1360 m, *Standley* 76538 (F); Cerro Alcoba, just east of Jalapa, 1300-1700 m, *Steyermark* 32577 (F). SACATEPÉQUEZ: near Antigua, 1500-1600 m, *Standley* 58628 (F). CHIMALTENANGO: Alameda, *Johnston* 356 (F); along road from Chimaltenango to San Martín Jilotepeque, 1500-1900 m, *Standley* 57980 (F); near Finca La Alameda, near Chimaltenango, 1830 m, *Standley* 59096 (F). HONDURAS. MORAZÁN: San Antonio, *Rodriguez* 1458 (F); El Quebracho above El Zamorano, ca 950 m, *Standley* 377 (F); along and near Río Agua Amarilla above El Zamorano, 1000-1200 m, *Standley* 13837 (F); along Río Agua Amarilla above El Jicarito, 900-1100 m, *Standley* 27320 (F). EL PARAÍSO: near cumbre of Yuscarán Road, 1450 m, *Standley* 29294 (F).

Irregularities in pollen production in *Eupatorium anchisteum* suggest that it may be apomictic. Pollen was not observed in any specimens of this species. At anthesis the contents of the anthers resemble oil droplets of varying sizes which apparently lack an exine. Full fruit set never-

theless occurred in many of the specimens. Two previous investigators (Holmgren 1919; Sparvoli 1958, 1960) have demonstrated apomixis in species of *Eupatorium* in which fruit was set despite abortive pollen.

The following specimens of *E. anchisteum* have pre-anthesis florets with the anthers devoid of recognizable pollen grains, the contents instead resembling oil droplets: *Johnston* 356 (F); *Rodriguez* 1458 (F); *Standley* 377 (F), 27320 (F), 76538 (F), 77248 (F); *Steyermark* 30650 (F). The following specimens have no pre-anthesis florets but an examination of post-anthesis florets revealed "oil-droplets": *Standley* 27471 (MSC), 57980 (F), 58628 (F), 59096 (F).

Specimens of *E. anchisteum* have been determined previously as *E. muelleri*, and it is to this species that *E. anchisteum* seems most closely related. The specific epithet *anchisteum* (Gr. next of kin) is meant to express this relationship. There is no indication of intergradation between the two taxa, however, even though they overlap in range and appear mixed in a single collection. There are very clear morphological differences between them, which we believe justify recognition of the two taxa as species.

Although *E. anchisteum* is most similar to *E. muelleri*, it also has features in common with *E. aschenbornianum* and *E. choricephalum*. From the former it may be distinguished by the glabrous phyllaries as well as fewer heads on longer pedicels (hence a more lax inflorescence). The pubescence at the base of the stem of *E. aschenbornianum* is reddish whereas that in *E. anchisteum* is usually white; thus the stems of *E. aschenbornianum* appear tawny when dried while those of *E. anchisteum* have a grayish appearance. The densely pilose stem, the presence of large moniliform hairs on the leaves, and the glabrous outer phyllaries of *E. anchisteum* distinguish it from *E. choricephalum*.

2. **Eupatorium muelleri** Sch. Bip. ex Klatt

Eupatorium muelleri Sch. Bip. ex Klatt, Leopoldina **20**: 90. 1884. Type: MEXICO. OAXACA (?): "Tala." *Liebmann* 67 (C, holotype, MSC photo 4578; GH).

Mallinoa corymbosa Coult. Bot. Gaz. **20**: 47. 1895. Type: GUATEMALA. SANTA ROSA: Volcan Jumaytepeque, 6000 ft, *Heyde & Lux ex J. D. Smith* 4255 (F, holotype, MSC photo 9149; US).

Erect perennial herb 30-60 cm high; stems terete, striate, purple, rather densely doubly pilose below, becoming glabrous above; leaves opposite, confined to the lower 1/4 of the plant, sometimes subrosulate (upper leaves, when present, much reduced and short-petiolate to subsessile); blades 25-80 mm long, 10-60 mm wide, ovate to ovate-rhomboid (occasionally suborbicular), acuminate, truncate to cuneate-acuminate at the base, 3-7 nerved, sparsely pubescent on both surfaces with large moniliform trichomes especially along the nerves below; inflorescence an open, few-headed corymb; heads 4-6 mm high, 6-9 mm wide, with 85-125 florets, on long glabrous pedicels up to 7.5 cm long; involucre campanulate, phyllaries biseriate, subequal, glabrous, ovate, obtuse to acute, scarious margined, ciliate; corollas white, lobes pubescent; achenes 1.5 mm long, hispid especially along the ribs; pappus of brittle white barbellate bristles 3.5 mm long.

Specimens examined. MEXICO. JALISCO: km 926-927 on Mex 80 from Guadalajara to Barra de Navidad, *Grashoff* 188 (MSC); steep mountainsides 3-5 road miles above (north of) La Cuesta, road to Talpa de Allende; elevation 950-1000 m, *McVaugh* 21246 (MICH); cultivated from seed of the preceding, *Grashoff* 277 (MSC). HIDALGO: Tulancingo, ravine near Apulco, 2200 m, *Moore* 2098 (GH). STATE OF MEXICO: Dist. of Temascaltepec, Cajones, 2480 m, *Hinton* 2374 (US); Tejupilco, 1340 m, *Hinton* 2710 (F, GH, US). MICHOACAN: Uruapan, 4500 ft., *Pringle* 10121 (F, GH, MSC, US). GUERRERO: Mina, Toro Muerto, 2350 m, *Hinton et al.* 14764 (MICH, US). OAXACA: Sierra de San Felipe, 7500 ft, *Pringle* 6055 (GH, MSC, US); 16 km al NE de Oaxaca sobre la carratera a Ixtlan de Juarez, *Rzedowski* 19214a (MSC); Cerro de San Felipe, 6000-7000 ft, *C. L. Smith* 305 (F). OAXACA (?): Tala [Talea ?], *Liebmann* 67 (C, holotype; GH). CHIAPAS: one mile N of Junction of Mex 195 and Mex 190 on Mex 195, *Grashoff* 236 (MSC). GUATEMALA. HUEHUETENANGO: along road E of San Sebastián, ca 1800 m, *Standley* 81454 (F); near crossing of Río San Juan Ixtlán E of San Rafael Pétzal, ca 1730 m, *Standley* 83060 (F). CHIQUIMULA: along Río Tacó between Chiquimula and Montaña Barriol, 3-15 miles NW of Chiquimula, 500-1200 m, *Steyermark* 30641 (F). JALAPA: vicinity of Jalapa, 1360 m, *Standley* 76696 (F); Montaña Durazno, 2 mi E of San Pedro Pinula, 1400-1800 m, *Steyermark* 32976 (F). CHIMALTENANGO: Alameda, *Johnston* 493 (F); Barranco de La Sierra, SE of Patzúm, ca 2100 m, *Standley* 61602. SANTA ROSA: Volcán Jumaytepeque, 6000 ft, *Heyde & Lux ex J. D. Smith* 4255 (F, holotype of *Mallinoa corymbosa*; US). HONDURAS. COMAYAGUA: vicinity of Siguatepeque, 1080-1400 m, *Standley* 56032 (F). MORAZÁN:

along and near Río Agua Amarilla, above El Zamorano, 1000-1200 m, *Standley* 13837.

The relationships of *E. anchisteum* and *E. muelleri* are discussed under the former species. Like *E. anchisteum*, *E. muelleri* appears to be apomictic. The following specimens of *E. muelleri* have pre-anthesis florets with anthers devoid of recognizable pollen grains, the contents instead resembling oil droplets; *Grashoff* 188 (MSC), 236 (MSC), 277 (MSC); *Hinton* 2710 (F); *Pringle* 10121 (MSC); *Standley* 77626 (F); *Steyermark* 30641 (F). The following specimens have no pre-anthesis florets but an examination of post-anthesis florets revealed "oil droplets": *Johnston* 483 (F); *Standley* 50632 (F), 61602 (F), 81454 (F). One specimen (*Standley* 83060, F) contained only post-anthesis florets with anthers which appeared totally empty.

When grown in the experimental garden and greenhouse, plants of *E. muelleri* exhibit a more robust habit than those in the native habitat. They achieve a higher stature (to one meter), have a greater degree of branching, and have leaves distributed farther up the stem. They maintain, however, the large heads in open inflorescences and the characteristic leaf shape of the species.

Eupatorium muelleri is very similar to *E. lasium*, from which it is readily separated only by its glabrous pedicels. In other respects the two species appear to intergrade or to form two extremes of a continuum. *Eupatorium lasium* usually has a more robust habit with a much-branched inflorescence and a greater number of smaller heads. The specimens now referred to *E. lasium* may be local isolates of the more widespread *E. muelleri*, but such a conclusion would have to be reinforced by more extensive collections than are now available.

3. **Eupatorium bellidifolium** Benth.

Eupatorium bellidifolium Benth. Pl. Hartweg. 43. 1840. Type: MEXICO. HIDALGO: mountains near Apulco, *Hartweg* 330 (K, holotype, MSC photo 1644).

Erect scapose perennial herb 15-35 cm tall; stems terete, sparsely doubly pilose below, glandular and pilose above; leaves subrosulate,

opposite, petiolate, reddish beneath; blades obovate-orbicular, 1-6 cm long, 0.8-4 cm wide, crenate or serrate, base subcuneate-acuminate, with 3-7 nerves branching from a short distance above the base (occasionally appearing to branch directly from the base, particularly in depauperate specimens), pilose with large moniliform trichomes on both surfaces, especially along the veins beneath; inflorescence a diffuse, few-headed corymb, occasionally with but two or three heads; pedicels densely pubescent with both glandular and eglandular trichomes; heads with 40-100 florets, 8-10 mm wide, 6-8 mm high; involucre campanulate, phyllaries virescent, lanceolate to linear-lanceolate, acuminate, subequal, 2- (3-) ribbed, 3-nerved, the outer with glandular trichomes; corollas white, 4 mm long, glabrous except on the lobes; achenes dark brown, 1.5-2.0 mm long, hispid especially along the ribs; pappus of brittle white barbellate bristles 3 mm long, sometimes reddish.

Specimens examined. MEXICO. SINALOA: Sierra Madre Occidental, in forest at Loberas summit, 6350 ft. *Goodman* 7420 (US); Sierra de la Durango, Cerro de las Cruces, San Ignacio, 2160 m, *Montes & Salazar* 105 (US). JALISCO: Sierra del Halo, near lumber road leaving the Colima highway, 7 miles SSW of Tecalitlán and extending southeasterly to San Isidro, 1700-1800 m, *McVaugh & Koelz* 1285 (MICH). HIDALGO: mountains near Apulco, *Hartweg* 330 (K, holotype). STATE OF MEXICO: Temascaltepec, Cumbre-Cruz, *Hinton et al.* 8688 (F, GH, US). MICHOACAN: Zitacuaro, Cerro Aguila, 2750 m, *Hinton et al.* 13555 (GH, MICH, US). GUERRERO: Cruz de Ocote, ca 25 km WSW of Camolta, Mun. de Chichihualco ca 50-60 km W of Chilpancingo, *Feddema* 2879 (MICH); *idem loc.*, *Rzedowski* 14945 (MICH); Cerro Alquitrán cerca de Mazatlán, municipio de Chilpancingo, *Rzedowski* 23663, (MSC); Mina, Campo Marado, 2420 m, *Hinton et al.* 11171 (GH, US); Cerro Azul, 2500 m, *Hinton et al.* 14945 (MICH, US). OAXACA: near first summit of road about 9 miles NE of Mitla on the road to San Lorenzo, 8000 ft, *Ernst & Delgadillo* 2228 (US); cultivated from seed of the preceding, *Grashoff* 276 (MSC); Ixtlan de Juárez, *Kruger & Gillespie* 44 (GH); Sierra de San Felipe, 8000 ft, *Pringle* 6056 (GH, MICH, MSC, US); Sierra de Clavellinas, 8000 ft, *C. L. Smith* 367 (F, US); 16 km NE of Oaxaca, sobre la carretera a Ixtlan de Juárez, *Rzedowski* 19214 (MICH). CHIAPAS: near Piedracitos 7 km E of San Cristobal las Casas, Mun. of Chamula, 7200 ft, *Breedlove* 8005 (MICH). GUATEMALA. ZACAPA: between Loma El Picacho and Cerro de Monos, 2000-2600 m, *Steyermark* 42760 (F).

Three specimens were examined for anther content. Two had pre-anthesis florets with anthers completely devoid of any recognizable pollen grains, the contents instead resembling oil droplets. These were: *Grashoff* 276 (MSC), *Rzedowski* 23633 (MSC). *Pringle* 6065 (MSC) contained only post-

anthesis florets but an examination of the anthers revealed few pollen grains and many "oil droplets".

4. **Eupatorium lasium** Robins.

Eupatorium lasium Robins. Contr. Gray Herb. **68**: 21. 1923. Type: MEXICO. MICHOACAN: vicinity of Morelia, vers la Loma de la Huerta, 1950 m, *Arsène* 5788 (GH, holotype, MSC photo 5980; US).

Erect perennial herb 5-6 dm or more tall; roots of 6-12 gray-black fibrils ca 2 mm thick; stems terete, ca 5 mm thick at base, densely doubly pilose below, becoming sparsely and singly pilose above; leaves opposite, long-petiolate, ovate, broadly cordate, short-acuminate, coarsely crenate to obtusely dentate; blades white-pilose on both surfaces with large moniliform trichomes, 3-7 cm long, 2.7-6 cm wide, 3-7-nerved from just above the acuminate base; petioles sometimes winged; inflorescence a lax panicle, bracts foliaceous but much reduced, pedicels 5-18 mm long, short pubescent; heads about 8 mm high, 8 mm wide, with 60-87 florets; involucre campanulate; phyllaries 23-30, subequal, lanceolate to oblanceolate, obtuse to acute, scarious margined, the apex long ciliate; corollas white, throat and/or lobes pubescent, throat enlarged, cylindrical, lobes ca 1.8 mm long, deltoid; achenes black, ca 1.8-2.2 mm long, hispid especially along the ribs; pappus of thin brittle white barbellate bristles ca 4 mm long.

Specimens examined. MEXICO. MICHOACAN: vicinity of Morelia, vers la Huerta, 1950 m, *Arsène* 5440 (US); *Arsène* 5788 (GH, holotype; US); Loma Santa Maria, 1950 m, *Arsène* 5867 (US); Cerro San Miguel, 2100 m, *Arsène* 7272 (US); Cerro Azul, 2100 m, *Arsène* 7275 (US).

5. **Eupatorium choricephalum** Robins.

Eupatorium choricephalum Robins. Proc. Amer. Acad. **54**: 239. 1918. Type: MEXICO. JALISCO: near Guadalajara, *Pringle* 11824 (GH, holotype; F, MICH, MSC, US).

Eupatorium arsenei Robins. Contr. Gray Herb. **104**: 10. 1934. Type: MEXICO. MICHOACAN: vicinity of Morelia, Carrindapaz, *Arsène* 6080 (GH, holotype, MSC photo 5928; US).

Erect or slightly decumbent perennial herb about 1 m tall; stems terete, often purplish, doubly pilose below, singly pilose above; leaves opposite, petiolate, becoming subsessile and reduced above, broadly ovate, acuminate, broadly cordate to truncate at the base, crenate, the base of the blade acuminate at the insertion of the petiole, blade ca 3-7.5 cm long, 2.5-6 cm wide, thin, sparsely pilose on the veins with small trichomes, appearing glabrous without magnification, veins 3-8,

separating at the very base of the blade; inflorescence usually an open panicle but clusters of heads sometimes remote; pedicels filiform, 3-18 (-25) mm long, pubescent; heads 5-6.5 mm long, 5-7 mm wide, with 30-60 (-84) florets; involucre campanulate, phyllaries virescent, subequal, oblong to linear-lanceolate or linear-oblong, obtuse, acute, or often acuminate, 2-ribbed, 3-nerved, scarious margined, ciliate, the outer dorsally pilose; corollas white, throat ampliate, lobes 0.3-0.9 mm long; achenes dark brown, 1.5-2 mm long, hispid especially along the ribs; pappus bristles white, short barbellate, brittle, 4 mm long.

Specimens examined. MEXICO. CHIHUAHUA: "South-western Chihuahua," *Palmer* 276 in 1885 (GH, US), Mapula Mts., *Pringle* 747 (GH, MICH, MSC). SINALOA: San Ignacio, San Juan, Lasbreas, *Ortega* 6885 (F). DURANGO: city of Durango and vicinity, *Palmer* 857 in 1896 (F, GH, MSC, US). NAYARIT: mountains 10 miles SE of Ahuacatlan on the road to Barranca del Oro and Amatlan, 1100-1300 m, *McVaugh & Koelz* 782 (MICH). JALISCO: Barranca de San Juan de Dios ca 15 km E of Pihuamo, eastern slopes of Sierra de los Corales, Mun. de Tecalitlan, 1200-1300 m, *Feddema* 2201 (MICH); Sierra del Tigre, 3 miles S of Mazamitla, 2100-2200 m, *McVaugh* 13605 (MICH); *McVaugh & Koelz* 418 (MICH); *McVaugh & Koelz* 419 (MICH); Sierra de la Campana along road to Mascota 7-8 miles NW of Los Volcanes, 1900-2000 m, *McVaugh* 13692 (MICH); steep mountainsides 4.5 miles NNE of Talpa de Allende N of the road, 1450-1500 m, *McVaugh* 20203 (MICH); mountains 12-15 miles SSE of Autlan on lumber road to Corralitos, 4-10 miles above (SE) Ahuacapan, 1500-2000 m, *McVaugh & Koelz* 998 (MICH); in the barranca at Puente San Pedro, 5 miles SW of Tecalitlan, 1200 m, *McVaugh & Koelz* 1310 (MICH); Chalapa, *Palmer* 712 in 1886 (GH, MICH, MSC, US); near Guadalajara, *Pringle* 11824 (GH, holotype; F, MICH, MSC, US); Calabazas, *Reko* 4868 (US); Mata de Bule, Sierra de los Corales, Mun. de Tecalitlan, 1300 m, *Rzedowski* 17316 (MICH, MSC); Llano Verde, cerca de los Corales, Mun. de Tecalitlan, Sierra de los Corales, 1600 m, *Rzedowski* 17446 (MICH, MSC). VERACRUZ: Orizaba, *Botteri* 494 (GH). MORELOS: Cuernavaca, *Bourgeau* 1215 (F, GH); Huitzilac, *Lyonnet* 819 (US); near Cuernavaca, *Pringle* 11342 (GH, US). STATE OF MEXICO: Temascaltepec, Rincon, *Hinton* 129 (US). MICHOACAN: vicinity of Morelia, Cerro San Miguel, 2200 m, *Arsène* 5302 (US); vers la Huerta, 1950 m, *Arsène* 5439 (US); *Arsène* 6619 (US); Carrindapaz, 2200 m, *Arsène* 6080 (GH, holotype of *E. arsenei*; US); 5 miles N of Patzcuaro, 6300 ft, *Cronquist* 9726 (MICH); W-facing slopes of Cerro de Carboneras above Río Cupatizio, ca 22 km S of Uruapan, *King & Soderstrom* 4809 (US); near Uruapan, 4800 ft, *Pringle* 10099 (F, GH, MICH, MSC, US). GUERRERO: Mina, Chilacayote-Manzito, 1850 m, *Hinton et al.* 14936 (US); 2 km N of Taxco, over road to Amacuzac, 1750 m, *Rzedowski* 21494 (MSC).

Eupatorium choricephalum is a widely distributed, vari-

able Mexican species from which *E. arsenei* cannot be satisfactorily separated. Robinson (1934) distinguished the two species on the basis of the narrower, more acute phyllaries and more diffuse panicle in *E. choricephalum*. From specimens now available, however, it appears that variation in these characters is continuous between the extremes. Notes and sketches preserved in the Gray Herbarium suggest that Robinson used Palmer 857 in 1896 in drawing up his description of *E. choricephalum*, but he designated as type *Pringle* 11824 (misprinted 11924). These two specimens differ principally in the size of the crenations of the leaf margins.

Eight specimens were examined for anther content. One (*Pringle* 11824, MSC) had pre-anthesis florets with anthers which contained few "oil droplets" and many pollen grains of irregular sizes and shapes, a high percentage of which were aborted. Five specimens with pre-anthesis florets had anthers which contained few if any pollen grains and many "oil droplets": *Palmer* 712 in 1886 (MSC); *Pringle* 747 (MSC); *Rzedowski* 17316 (MSC), 17446 (MSC), 21494 (MSC). Two specimens had only post-anthesis florets but an examination of the anthers revealed the presence of "oil droplets" indicative of pollen sterility: *Palmer* 857 in 1896 (MSC); *Pringle* 10099 (MSC).

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II. A NEW SPECIES OF EUPATORIUM (SECTION HEBECLINUM)[1]

J. L. Grashoff and J. H. Beaman

During an examination of undetermined specimens of *Eupatorium* at the U. S. National Herbarium, the Field Museum, and the University of Michigan Herbarium, two collections were found representing a previously undescribed species which is characterized as follows:

Eupatorium ovandense Grashoff & Beaman, sp. nov.

Type: Mexico. chiapas: Mt. Ovando,[2] 1000 m, *E. Matuda* 3922, Nov. 14-18 1939 (us 2422509, holotype, msc photo 9236; mich).

Herba grandis, suffrutescens. Rami quinquesulcati, fistulosi. Folia glabrata, ovata cum ca 5-11 lobis acutis. Petioli 2.5-7 cm longi, glabri, saltem superne alati. Laminae 5-13 cm latae, 6-17 cm longae, irregulariter crenatae, utrinque glandibus sessilibus aureis. Inflorescentiae paniculatae, conicae ad subglobosae, ramis viscido-pilosis. Capitula multa. Involucra campanulata, ca 4-5 mm alta, ca 3-4 mm lata. Phyllaria ca 15, pilosa, sessili-glandulosa, 1-2 costata, exteriora lanceolata et acuta, 2 mm longa, interiora lineari-acuta, 4.5 mm longa, ciliata. Receptacula reticulato-ciliata. Flosculi ca 15. Corollae ca 4 mm longae, amethysteae, infundibuliformes sine tubis constrictis, superne raro sessili-glandulosae, basi duplo-bulbosae. Lobi breves vix 0.5 mm longi, obtusi. Rami styli 5 mm longi, subclavati. Achaenia columnaria, brunnea, 2-3 mm longa, 5-costata, precipue secus costas hispida. Setae pappi ca 24, albae, barbellatae, 3 mm longae.

Large suffrutescent herb; stem 5-grooved, fistulose; leaves ovate with 5-11 acute lobes, glabrate; petioles 2.5-7 cm long, winged (at least above), glabrous; blades 5-13 cm wide, 6-17 cm long, with yellow sessile glands on both surfaces, irregularly crenate; inflorescence a large conical to subglobose panicle, the branches viscid-pilose, heads numerous; involucre campanulate, ca 4.5 mm high, ca 3-4 mm wide; phyllaries ca 15, pilose and sessile-glandular, 1-2-ribbed, the

[1]We appreciate the facilities provided for this study by the curators of the Field Museum, University of Michigan Herbarium, and the U. S. National Herbarium. Dr. M. Kabalin kindly edited the Latin diagnosis.

[2]Mount Ovando is not indicated on the standard maps of Mexico. From the local populace its location was established as the first peak (over 2000 m high) to the NW of Esquintla, Chiapas, in the Sierra de Soconusco.

Plate 1430

Figure 1. *Eupatorium ovandense* Grashoff & Beaman, holotype. Insert: involucre; phyllaries showing change in size and shape from outer (left) to inner (right); floret with many of the fragile pappus bristles broken off (× 2).

outer lanceolate, acute, 2 mm long, the inner linear-acute, 4.5 mm long, ciliate; receptacle reticulate-ciliate; florets ca 15, corollas ca 4 mm long, purple, funnelform without constricted tubes, rarely sessile-glandular above, doubly bulbous at the base; lobes short, scarcely 0.5 mm long, obtuse; style branches 5 mm long, subclavate; achenes columnar, brown, 2-3 mm long, 5-costate, hispid especially along the ribs; pappus of ca 24 white barbellate bristles 3 mm long.

Figure 1.

Additional specimens examined. MEXICO. CHIAPAS: Mt. Ovando, Escuintla, *Matuda* 16258, November 14, 1945 (F, US).

Eupatorium ovandense is evidently related to *E. incomptum* DC. (section *Hebeclinum*), similarly large, suffrutescent herb which occurs in central and southern Mexico and Guatemala. These species may be distinguished as follows:

Phyllaries acute, becoming linear within; florets purple, rarely with yellow sessile glands on the lobes; leaves without a prominent veining pattern on the abaxial surface ..... *E. ovandense*

Phyllaries obtuse, of approximately equal width throughout; florets not purple but with many orange or brown sessile glands throughout the corollas; leaves with a conspicuous reticulate veining pattern on the abaxial surface ..... *E. incomptum*

Postscript. While this manuscript was in press a publication by R. M. King and H. Robinson (Brittonia **21**: 275-284. 1969) has proposed transfer of *Eupatorium ovandense* to the genus *Decachaeta*. They consider structure of the anther appendage to be the unifying character of *Decachaeta*. Anther appendages are variable in still other species of *Eupatorium*, however, and may relate to pollination mechanisms (Grashoff and Beaman, Brittonia, in press). Furthermore, *Decachaeta sensu* King and Robinson would appear to include several discordant elements resulting in too much diversity for a small segregate genus. We therefore consider *E. ovandense* and *E. incomptum* more appropriately left in *Eupatorium*.

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A NEW WEED INTRODUCTION IN NEW ENGLAND, ATRIPLEX SIBIRICA. — Some years ago Prof. Burton N. Gates sent me a plant for identification that was not included in the eighth edition of Gray's Manual. It was an Old World type of *Atriplex*, and so I sent it to Prof. Paul Aellen, of Basel, Switzerland, the chief authority on the Chenopodiaceae. Aellen identified the specimen as *Obione muricata* Gaertn., a native of Siberia and Turkestan.

The status of *Obione* Gaertn. as a genus distinct from *Atriplex* L. is still debatable and perhaps a matter of individual preference. Ulbrich, in the second edition of Engler and Prantl's Die Natürlichen Pflanzenfamilien (vol. 16c, 1934) recognized it, and Aellen follows him, although with some reservations. The chief, and perhaps only, character is in the fruiting pistillate perianth segments being united to above the middle or throughout, rather than nearly free as in typical *Atriplex* species such as *A. patula* L., *A. hortensis* L., and *A. rosea* L. There are two "*Obione*" species that occur within the Gray's Manual range, viz. *A. argentea* and *A. arenaria* Nutt. From these *Atriplex sibirica* L. (*Obione muricata* Gaertn.) differs in having the fruiting perianth segments united to the apex and strongly spiny on the back throughout. Since the perianth is incurved at the apex, the mature fruit is almost completely enclosed except for a minute apical tube.

The following description is translated from Aellen's description in his paper "Die orientalischen Obione-Arten" (Verhandl. Naturforsch. Gesell. Basel 49: 131-137. 1937-38).

Atriplex sibirica L. Sp. Pl. ed. 2, 1493. 1763.

Obione muricata Gaertn. Fruct. 2: 198, *t. 126, f.5*, 1791.

Obione sibirica (L.) Fisch. Cat. Hort. Gorenk. 25. 1808.

Annual, up to 60 cm. high, many-branched, with elongate, glabrate branches; middle leaves mostly alternate, oval-deltoid, up to 7 cm. long (including the petiole 1 cm. long), and 3 cm. wide, with simple or double lobe-like teeth below the middle, above the middle with sinuately curved teeth, the apex more or less acute, the base rounded, slightly

decurrent into the petiole, beneath with prominent nerves, gray-pulverulent, above glabrescent; smaller leaves lanceolate, more or less entire; male flowers very few in balls at the end of branchlets; pistillate perianth up to 6 mm. long (including the pedicel), up to 4 mm. broad, stellate-scaly when young, the lower part round, connate upwardly to a small opening, woody in fruit, irregularly tuberculate and echinate, with a pedical 2-3 mm. long, ca. 1 mm. thick at the upper end, inconspicuously ridged from the decurrent nerves; pericarp membranous, more or less adherent; seed entirely enclosed within the woody perianth segments, ca. 2 mm. in diameter, red-brown, with upwardly turned radicle and 2 small separated styles.

Specimen examined: Dump of Queensbury Combing Company, Auburn, Worcester County, Massachusetts, July 16, 1949, *Burton N. Gates* 31888 (US), Clark Univ., New England Bot. Club, (GH).

It will be interesting to find out if this plant persists. Since it grows naturally in a cold region, it may very well find New England a congenial habitat.

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